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OBJECT-ORIENTED

SOFTWARE REQUIREMENTS SPECIFICATION

FOR THE

UH-1 HELICOPTER FLIGHT SIMULATOR

Prepared For:

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The purpose of this document is to explore object-oriented requirements analysis. The document is divided into three sections. The first section is a theoretical overview of object-oriented requirements analysis. It attempts to define what object-oriented requirements analysis is and to justify its use. The second section details the approach adopted for identifying and formulating the requirements listed in this document. The third section contains a case study, in which the approach described in the preceding section is applied. Keywords:

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PREFACE

With the current popularity of object-oriented design, the issue of object-oriented requirements analysis (OORA) has lately become a much-discussed item. IIT Research Institute has been investigating this topic for about a year. This document represents the fruits of our labors. It contains both a theoretical discussion of object-oriented requirements analysis and an extensive example of an object-oriented requirements analysis, which is in full compliance with the relevant sections of DOD-STD-2167A. The example is a requirements analysis for the UH-1 Flight Simulator. It was chosen because IIT Research Institute has been involved in an IV & V role in the redevelopment of the UH-1 Flight Simulator software in Ada.

The UH-1 project is comprised of two CSCI's--a Real-Time CSCI and a Non-Real-Time CSCI. The Real-Time CSCI is in turn broken down into an Instructor Operator Station (IOS) CSC, which handles the control of the Flight Simulator, and a Trainee Station CSC, which manages the Flight Simulator itself. This document specifies the requirements for the IOS CSC only. This portion was chosen because the requirements of the IOS CSC are less technical than those of the Trainee Station CSC and hence are more easily understood by the lay person. In addition, the problem of transforming the requirements of this part of the system into object-oriented requirements is not as straightforward as for the Trainee Station CSC, and so it was felt that the IOS CSC would present a more rigorous test case for object-oriented requirements analysis.

IIT Research Institute feels that the sample object-oriented requirements analysis contained in this document is a good example of what might come out of a requirements analysis for a redevelopment effort. The requirements for an initial development would probably be less detailed. If a redevelopment is to include all of the functionality of the earlier system, as this one is, then a great deal is known about what the system is supposed to do. Hence, requirements for such an effort will be correspondingly detailed. However, IIT Research Institute does not feel that the usefulness of this document is limited to redevelopments: if anything, it includes too much information, not too little.

This document owes much to the good offices of certain individuals not directly connected with the project. First and foremost, the OORA team would like to thank Mr. Robert Paulson, who, as the government project manager for the UH-1 redevelopment effort, has sponsored this research financially and has been very positive throughout. Were it not for his support and encouragement, this project would have gotten nowhere.

In addition, the OORA team is indebted to the work of Grumman Electronics Systems, the actual developers of the UH-1 Flight Simulator software. Their familiarity with such systems in general and their documentation of the requirements for this system in particular have provided invaluable reference information for the OORA team.

The OORA team would also like to thank the staff at EVB, Inc., especially Mr. Edward Berard, for being a constant source of stimulation. The team first heard of OORA from EVB, and during the fall of 1988 two members of the team attended an OORA seminar at EVB. Although the techniques presented in this document are those of IIT Research Institute alone, their final appearance was decidedly influenced by the exposure of the OORA team to EVB's methodology.

IIT Research Institute has developed an automated tool written in Ada to partially support the OORA methodology contained herein. Much of the document was generated using this tool. There is no reason why this tool cannot be extended to automatically generate a system template in accordance with the equivalences shown in Table 1-1 of the Introduction.

As always, IIT Research Institute welcomes constructive criticism. IIT Research Institute believes that advances in software engineering can best come about through dialogue. Any comments our readers might wish to make regarding the method presented in this document would be more than appreciated by the OORA staff.
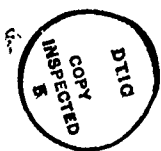
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Table of Contents

1 INTRODUCTION

The purpose of this document is to explore a rather new technique for analyzing requirements for software development: object-oriented requirements analysis (OORA). The document is divided into three sections. The first section is a theoretical overview of object-oriented requirements analysis. It attempts to define what object-oriented requirements analysis is and to justify its use. The second section details the approach adopted for identifying and formulating the requirements listed in this document. The third section contains a case study, in which the approach described in the preceding section is applied. It will, in effect, be an extract from a 2167A Software Requirements Specification, Section 3. The case study chosen was the UH-1 Flight Simulator redevelopment effort. This particular project was chosen because IITRI personnel have an intimate knowledge of it, due to having been involved with it in an IV & V role.

1.1 OBJECT-ORIENTED REQUIREMENTS ANALYSIS

The need for object-oriented requirements analysis arises from the fact that analysis, design, and coding all represent stages on a continuum of software development. Each phase feeds into the next. Therefore, it is unrealistic to suppose that one can complete one phase totally oblivious to how one's activities will affect subsequent phases. In this way, analysis impinges on design just as surely as design impinges on coding. No one would think of arguing that the design of a system is neutral, that it is independent of the implementation language. Why, then, should anyone advocate using a requirements analysis method that does not lend itself to the designated design methodology? On the contrary, a development effort is more likely to be successful if it includes a requirements analysis phase that is tailored to the needs of the design phase. If object-oriented design is the designated design methodology, then object-oriented requirements analysis provides the best transition from analysis to design.

It is important to recognize that the requirements analysis presents the view of world that the designer begins with; for unless the designer is to redo the requirements analysis, he/she cannot help looking at the world through the framework provided by the requirements analysis. This is compounded by the fact that the analyst and the designer are frequently not the same people. If the designer does not have firsthand knowledge of the system, he/she is totally dependent on the view of the world that the analyst presents. If the requirements are not expressed in an object-oriented manner, then it is very difficult for the designer to see the system in any other way. This fact alone can doom an object-oriented design before it ever gets started.

The only other alternative, when presented with a set of functional requirements, is to translate them into object-oriented requirements. But this is not really a very satisfactory option. First, it involves a significant amount of labor and time to do the requirements analysis twice. Second, now there will be two sets of requirements documents which must be kept in phase. Third, there is the psychological handicap mentioned above that having seen a system described from a certain point of view, it is very difficult for the analyst to reorient his/her thinking and view the system from a different perspective. Clearly, it would have been easier to have expressed the requirements in an object-oriented manner from the start.

An object-oriented requirements analysis also enhances the traceability between the requirements and the design. Although the designer is free to improve on the view of the world presented by the analyst, an object-oriented requirements analysis will still look a lot more like an object-oriented design than a functionally-oriented requirements analysis will. Since many functions may pertain to a single object and many objects may embody a single function, it is likely to be extremely difficult to achieve a straightforward mapping between functional requirements and design. The mapping between object-oriented requirements and object-oriented design, however, is likely to be much more direct.

Object-oriented requirements analyses also reduce integration problems at the coding stage. If a system is functionally partitioned by the requirements document, different teams are likely to be assigned to the different functions. But a single object may cut across several functions. The fact that two teams are really developing the same object from different points of view may not be realized until system integration, at which point it is probably too late to do anything about it. This situation cannot but detract from the conceptual integrity of the design.

Some may think that doing requirements analysis in a way that naturally leads into design is really doing design under another name in the requirements analysis phase. Absolutely not! Object-oriented requirements analysis is no different from any other analysis method in this respect. We can make as clear a distinction between required and non-required system objects as we can between required and non-required system functionality. Just as one can use structured analysis well or one can illicitly slip into design under the name of structured analysis, so one can use object-oriented requirements analysis well or one can use it in a sloppy manner. The method itself does not force the analyst to avoid making design decisions; it simply gives him/her the opportunity to do so.

For example, it is clearly a requirement that the UH-1 Flight Simulator have a ground track, which is a display of the helicopter's flight path plus a marker showing its current location, and which appears in any of several map displays. On the other hand, a class which buffers messages between the ground track and the helicopter is clearly not a requirement. Thus an object-oriented requirements document would mention the ground track but not the buffer class. The designer may in fact decide that a buffer is the best way to implement the communication between the ground track and the helicopter, but the buffer is not a requirement.

A requirements analysis provides, as it were, a default framework for a design. The designer may choose to accept this default. In that case, the design and coding phases would consist of nothing more than fillin‐ in the gaps left by the requirements analysis. But the designer is not obligated to do this. The designer may instead combine objects identified in the requirements analysis phase into larger objects, or he/she may break them apart into smaller objects. The situation is no different from functional requirements: there may be a one-to-one, a many-to-one, or a one-to-many relationship between a functional requirement and the subprogram(s) that implement it. The essential thing is that the requirement be satisfied in some way.

To continue the above example, the designer must include the ground track in the design somehow, but he/she may or may not actually have a class called "Ground Track." In the developed system several options are possible: the ground track may be handled by a package to which it corresponds directly; it may be incorporated into a package handling a higher level object, such as a map; or it may be modeled by two packages, one for the flight path and one for the current location. The designer is free to choose any of these implementations.

We have claimed that it is more difficult to derive an object-oriented design from a functionally-oriented requirements analysis (such as a structured analysis) than from an object-oriented requirements analysis. Why should this be? The answer is based on the fact that a requirements analysis method is merely a general way of organizing system requirements. Now functionally-oriented requirements analyses and object-oriented requirements analyses organize the system requirements differently. The former organize them by function, breaking down general operations into more specific ones; the latter organize the requirements by object, breaking down higher-level objects into lower-level ones. Thus, the structure of a system is more likely to fit in with an object-oriented design if that design is based on an object-oriented requirements analysis.

However, there is a deeper reason why object-oriented requirements analysis is more suitable for an object-oriented design. To see this, we must recognize that the software development process from design through coding is a continual process of making explicit what was only implicit in the original requirements. Since the ratio of requirements to lines of code is almost always very small, each requirement typically summarizes an enormous number of implementation features. Any two complete sets of system requirements will of necessity summarize all the features of the implemented system. The difference between them will not be in the features summarized, but in the way the features are grouped together. Thus, each requirements analysis will organize the system from a unique point of view.

Now an object-oriented design has very specific needs: objects must model the real world, and operations must be subordinate to objects. What this means is that an object-oriented design will need implementation features that are grouped together in a certain way. What is to insure that, out of all the possible groupings, these features will be grouped together in the way an object-oriented design needs them? Not unless we introduce object-oriented thinking from the start can we maximize the likelihood that serviceable objects and operations will come out of the requirements analysis phase. The entities identified by a functionally-oriented requirements analysis method are likely to be the wrong collections of implementation features--too general, too specific, or simply irrelevant to the needs of an object-oriented design. This is because functionally-oriented requirements analysis methods are really looking for different things than object-oriented requirements analysis, so that, even if both completely express a system's implementation features, it is unlikely that the way in which those features are organized will be as serviceable for an object-oriented design.

1.2 OBJECT-ORIENTED DESIGN

Given the need for object-oriented requirements analysis as a front end to object-oriented design, let us first of all attempt to clarify just what the object-oriented designer is looking for. The goal of object-oriented design is to identify the following:

o classes,
o subsystems,
o objects,
o states,
o attributes,
o operations.

The basic concept of object-oriented design is the notion of a class. A class is an entity that is characterized by a set of attributes and/or a set of operations. If the structure of the class is visible, then it is characterized by the data structure in terms of which it is defined, the implicit operations that pertain to that data structure, and any further operations that are explicitly provided in the library unit defining the class. If the structure of the class is not visible, then it is characterized only by the operations that are explicitly provided in the library unit defining the class, as well as any operations (such as equality) that may still be implicitly available.

Other concepts are based on the notion of a class:

o   A subsystem is a collection of classes. For example, in an aircraft simulator all classes pertaining to the aircraft components may be grouped together into the same subsystem.

o   An attribute is a property of a class. For example, "location" is an attribute because it is a property of the class "aircraft." An attribute is an instance of a class in its own right, which may in turn be characterized by other attributes. For example, "location" may be an instance of the class "coordinates," which is characterized by the attributes "latitude" and "longitude."

o   An object is an instance of a class other than an attribute. An example of an object is "Air Force One," which is an instance of the class "aircraft." (Sometimes the word "object" is misused to mean "class," but this obscures the distinction between a group and its instances. In this document we will use the word "class" to designate a group and the word "object" to designate an instance of a group.)

o   A state is an instance of all the attributes of an object. Suppose the class "aircraft" were characterized by the attributes "altitude," "air speed," "heading," and "location." Then the state of an aircraft would be the particular value of these attributes, for example, "1000 feet," "100 knots," "180 degrees," and "40 degrees north by 160 degrees west."

o   An operation is a process that either changes or provides information about the state of an object. For example, the operation "accelerate" would change the state of an aircraft; the operation "current speed" would provide information about the state of the aircraft.

Operations can be divided into constructors, selectors, and iterators: Constructors change the state of an object; selectors provide information about the state of an object. Iterators are performed on homogeneous complex objects (e.g., arrays, linked lists) and either change or provide information about the state of every element in the object; thus, iterators are either constructive or selective.

Table 1-1 illustrates how subsystems, classes, objects, attributes, states, and operations are commonly mapped onto Ada language constructs. In object-oriented requirements analysis we do not worry about the right hand column of Table 1-1. We are solely concerned with presenting a description of subsystems, classes, objects, attributes, states, and operations.

TABLE 1-1

Ada Equivalents to Object Oriented Entities

Object-Oriented Entity	Ada Equivalent
Subsystem	< none >
Class	Type Generic Package
Object	Variable Constant Task Package
Attribute	Type
State	Literal Aggregate
Operation	
Constructor	Procedure Entry
Selector	Function Procedure Entry

Iterator
    Constructive
    Selective
	Generic Procedure

Note: A package can represent an object only when the type in question and an object of the type are declared in the package body. It then serves as what Booch calls an "abstract-state machine" package.

1.3 DOD-STD-2167A

The relevant sections of the Software Requirements Specification (SRS) for specifying software requirements are 3.1, 3.2, 3.3, and 3.4. Section 3.1 is the CSCI External Interface Requirements, Section 3.2 is the CSCI Capability Requirements, Section 3.3 is the CSCI Internal Interface Requirements, and Section 3.4 is the CSCI Data Element Requirements. The following describes the conventions IIT Research Institute has adopted for representing an object-oriented requirements analysis within the framework required by DOD-STD-2167A.

1.   The required divisions of the SRS--CSCI External Interface Requirements (3.1), CSCI Capability Requirements (3.2), and CSCI Internal Interface Requirements (3.3)--have been divided into subsystems. Subsystems are in turn are broken down into classes. CSCI's and CSC's are assumed to map to subsystems, and CSU's and "capabilities" are assumed to map to classes.

2.   An informal description of the subsystem or class appears at the beginning of each subsystem section or class section. These informal descriptions should not be construed as system requirements. They are included solely for the purpose of giving the reader some background information to allow the document to be understood more easily.

3.   All system requirements are expressed in the form of lists. A list of the relevant subsystems appears at the beginning of Sections 3.1 and 3.2 of the SRS. Likewise, a list of all included classes appears at the beginning of each subsystem section of the SRS, and lists of attributes, imported data, exported data, processing, and interface requirements are provided for each class section.

4.   All requirements within each list are numbered sequentially to allow traceability to the design.

5.   If there are no requirements in a given list, the expression "< none >" appears in the list.

6.   Data elemer* and external and internal interface requirements are presented in tabular form. All data element lists state the data element name and its unit of measure or legal values.

All external interface lists state the data and its hardware and software locations; all internal interface lists state the data, its source, and its destination.

7.   For each class in the system a Class Interaction Diagram (CID) is included. These depict the external relationships between the class and other classes. The arrows in these diagrams represent cause-and-effect relations.

Figures 1-1 through 1-5 provide templates which illustrate these conventions.

3.2.x [subsystem name]

[informal description]

CLASSES

1.   [class 1]
2.   [class 2]

Figure 1-1. Subsystem Template.

3.2.x.y [class name]

[informal description]

ATTRIBUTES
1.   [attribute 1]
2.   [attribute 2]

IMPORTED DATA

1.   [datum 1]
2.   [datum 2]

EXPORTED DATA

1.   [datum 1]
2.   [datum 2]

PROCESSING

1.   [action 1]
2.   [action 2]

INTERFACES

1.   [action 1]
2.   [action 2]

Figure 1-2. Class Template.

DATA ELEMENTS

	Attribute	Unit of Measure / Value
1.	[attribute 1]	[value 1]
2.	[attribute 2]	[value 2]

Figure 1-3. Data Element Template.

EXTERNAL INTERFACES

	Data	Hardware Class	Software Class
1.	[datum 1]	[hardware location 1]	[software location 1]
2.	[datum 2]	[hardware location 2]	[software location 2]

Figure 1-4. External Interface Template.

INTERNAL INTERFACES

	Data	Source Class	Destination Class
1.	[datum 1]	[source 1]	[destination 1]
2.	[datum 2]	[source 2]	[destination 2]

Figure 1-5. Internal Interface Template.

2 APPROACH

What techniques can be used to insure that the requirements analysis will be one that is useful for object-oriented design? The hardest part of OOD is the first stage--identifying and specifying the relations among classes and operations. The following sections provide rules of thumb for performing object-oriented requirements analysis.

2.1 OORA RULES

This section enumerates the rules comprising IIT Research Institute's methodology for identifying classes and operations. The first set of rules contains various methods for identifying classes. The second set contains techniques for constructing Class Interaction Diagrams (CIDs), which were the OORA team's principal tool for specifying classes and identifying operations. The third set contains methods for identifying operations that pertain to each class. To help clarify the rules presented below, an example will be followed through the entire sequence. The example chosen is the Ground Track, which is a trace of the helicopter's simulated flight that is superimposed on a map display at the instructor operator station.

2.1.1 IDENTIFYING CLASSES

Method #1: Using Prior Documentation

1. If requirements documentation already exists for the system, enumerate the individual requirements for the system.

    In the case of the UH-1, requirements are contained in the System Specification and in the Instructor's Guide for the UH-1 Flight Simulator (FM 1-220). The first step would be to single out all of the individual requirements in these documents.

2. Group the individual requirements according to the classes to which they pertain.

    In the System Specification (pp. 9, 12) the following requirements can be grouped around a common component, the Ground Track:

    "A double action ground track erase [shall be implemented]. Action one is erase, and action two is stop erase."

"Provide display of an aircraft symbol to indicate aircraft position and allow it to flash when cockpit is in continue (not in freeze). Also, allow it to retrace the ground track during five minute playback."

"The cockpit CRT at the console and in the cockpit shall display the ground track . . . ."

The same may be done for FM1-220 (pp. 2-25 - 2-28):

"The ground track being flown can be traced on the display; the aircraft position is indicated by the leading edge of the track."

"To keep the display from becoming too cluttered, the console instructor can erase all or a part of the track. It can be erased completely, or only its oldest part can be removed to leave the more recent track history intact."

"The length of ground track displayed depends on the number of other items being displayed. Generally, 8 to 50 minutes of track can be seen at one time, although up to 105 minutes are available in computer memory and can be recalled for display."

"Five-minute time-ticks are shown on the right-hand side of the track . . . ."

"Sometimes it may be useful to enlarge a portion of the display in order to carefully inspect the ground track. This usually occurs when the cross-country map is being displayed. It is possible to enlarge the scale by zooming in on the aircraft's current position. The 1:10 scale of the 100- by 100-mile display can be increased to 1:2.5 or 1:1.25, thus displaying an area of 25 by 25 miles or 12.5 by 12.5 miles, respectively."

"To reduce the amount of clutter on the CRT, the IP can request that the console instructor erase the ground track."

"The console instructor can also restore ground track that has been erased."

2-2

Method #2: Top-Down Analysis

3.   Begin with the system as a whole. This is the highest-level class.

        Using this second method, one would start with the Flight Simulator as a whole.

4.   Subdivide it into its component classes.

        The Flight Simulator is divided into the Instructor Operator Station and the Trainee
        Station. The former controls the scenario that runs on the simulated helicopter; the latter
        is the simulated helicopter itself.

5.   Repeat step 4, until a level is reached where every class has a manageable number of
        requirements.

        The Instructor Operator Station is comprised of thre types of component--displays of the
        simulated flight, editing menus, and playback information. These three divisions may be
        called Flight Monitor, Editable Displays, and Flight History. The Flight Monitor is in turn
        comprised of various displayed components. These are the following:

                o   Problem Status Display
                o   Air Speed Graph
                o   Altitude Graph
                o   Cross Country Map
                o   Approach Map
                o   GCA Graph
                o   Ground Track
                o   Visual Error Alerts
                o   GCA Information

        At this level there has finally been reached a set of entities (one of which is the Ground
        Track) for which there seems to be a manageable number of requirements. The Ground
        Track has therefore been identified by another means.

Method #3:   Working Inward from Hardware

6.   Identify the hardware components of the system.

Using this third method, one would start with the hardware components of the system. One of these is the Graphic Display Controls. These are the devices that change the scale of the Ground Track and erase it. They are comprised of the push buttons GTRK 12.5 X 12.5, GTRK 25 X 25, GTRK 100 X 100, and GND TRK ERASE.

7.   Identify the classes which are required to interact with each hardware component.

In the first place, one should recognize that the push buttons identified above immediately interact with a simulated entity Graphic Display Controls, because the behavior of these and certain other push buttons must be coordinated by some governor (e.g., only one of them can be illuminated at one time).

8.   Repeat step 7 for each class which interacts with a previously identified class, until all required classes have been identified.

One must now ask what Graphic Display Controls interacts with. One of the things it interacts with is the Ground Track, because GTRK 12.5 X 12.5, GTRK 25 X 25, and GTRK 100 X 100 all change the scale of the Ground Track and GND TRK ERASE erases it gradually. Thus the Ground Track has been reached by a third means.

2.1.2 <u>CONSTRUCTING CLASS INTERACTION DIAGRAMS (CID'S)</u>

1.   Construct a diagram centered on each class identified. Represent this class by a circle. Label the central circle with the name of the class it represents.

One would first represent the Ground Track by a circle in the center of a CID, as shown in Figure 2-1.

2.   Draw a circle for each class which is required to interact with the central circle. Label each circle with the name of the class it represents.

2-4

Figure 2-1. CID Central Circle.

One would next add the circles for Graphic Display Controls, Trainee Station CSC, and Cockpit CRT because these classes are all required to interact with the Ground Track. This is shown in Figure 2-2.

3.   Draw arrows for each cause-and-effect relation between the central circle and all other circles in the diagram. The direction of the arrow represents temporal dependency. Usually, this will mean data flow: an arrow between class A and class B will mean that A has a particular piece of data first and that that data is then transmitted to B. Where there is no data flow, an arrow between class A and class B will indicate that a change in the state of B awaits a change in the state of A. In no case does the direction of the arrow represent control flow.

One would then add the arrows between all the circles on the CID, as shown in Figure 2-3.

4.   Repeat steps 1 - 3 for each circle interacting with the central circle. At this point there should be a class interaction diagram centered on each class required by the system.

One would then begin with each of the three surrounding circles on this CID and construct three more CIDs centered on each of these, and so on, until all required classes had been represented by a CID.

Figure 2-2. CID Circles.

2: Cockpit
4: Cockpit
6: Cross Country Map Scale
8: Longitude
   Latitude
10: Longitude
    Latitude
12: Navigational Facilities
13: Cross Country Map
15: Cross Country Map
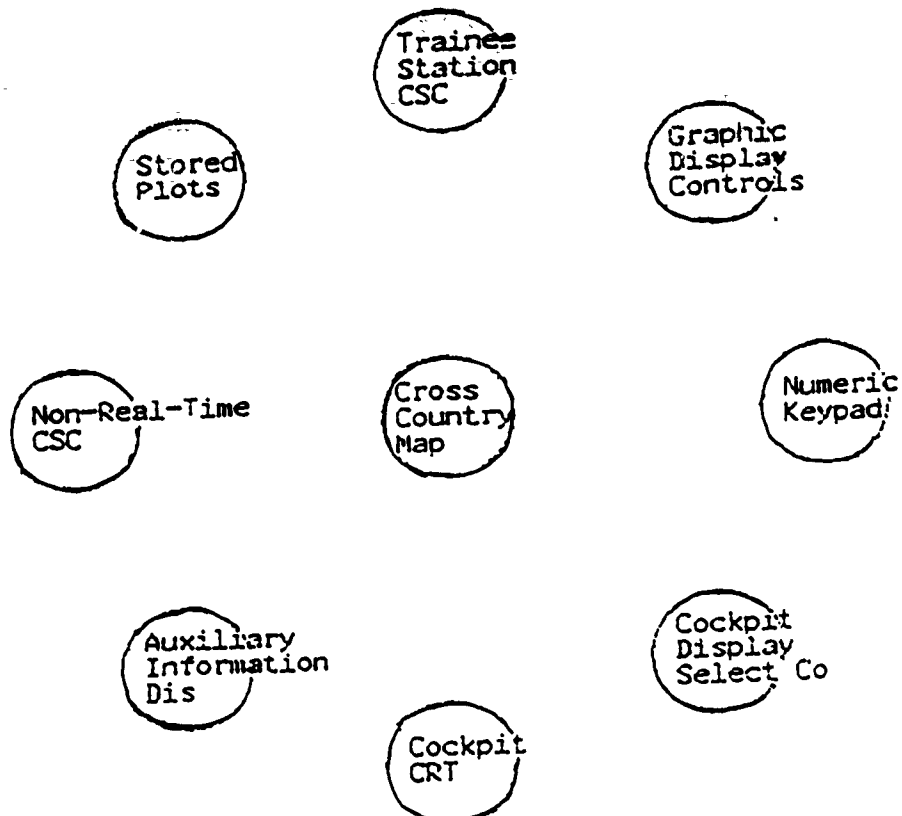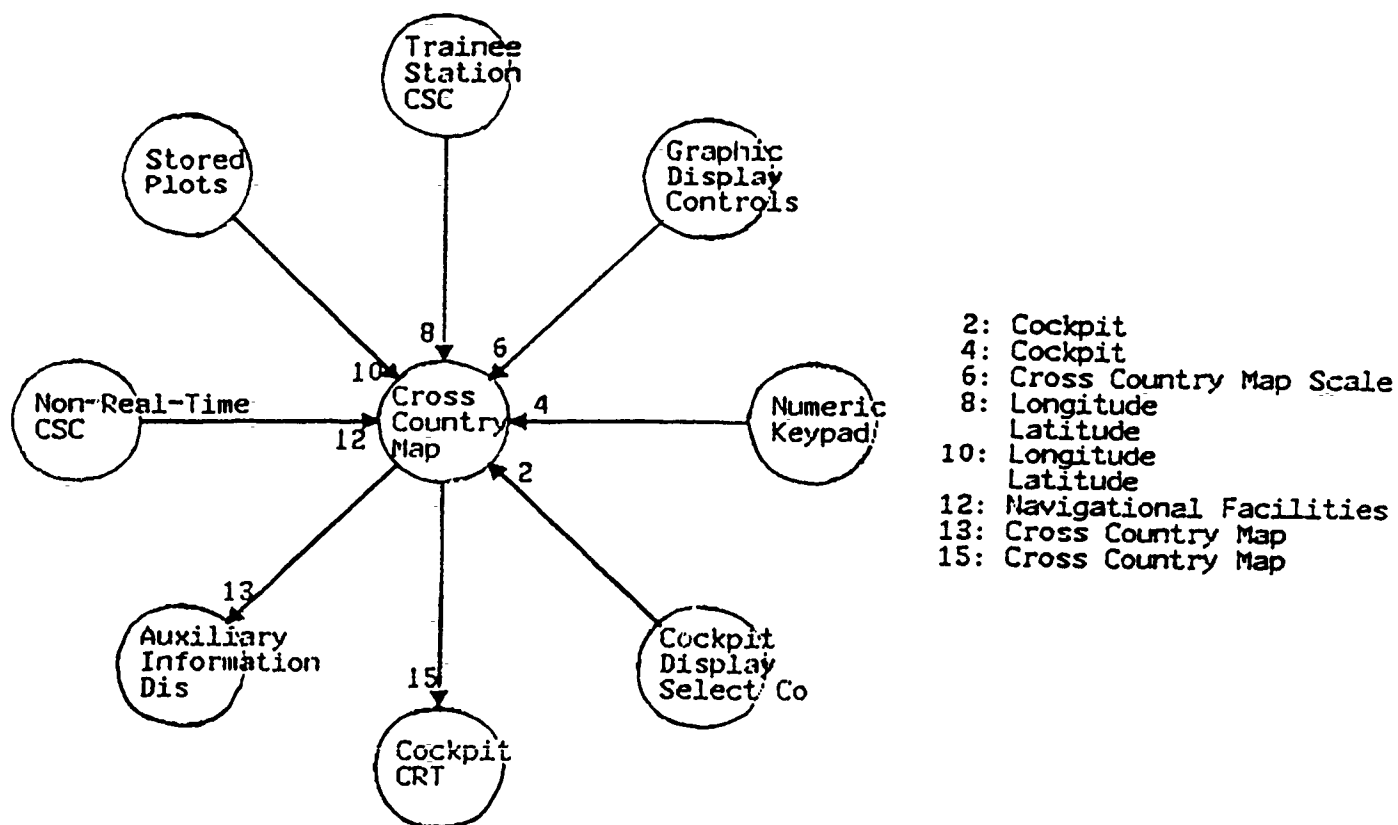
Figure 2-3. Final CID.

2.1.3 IDENTIFYING OPERATIONS

Method #1: Identifying Internal Operations

1. For each class, first ask whether it is active (i.e., does something all by itself) or passive (i.e., does something only in response to being stimulated from outside). If it is active, then in addition to any other operations it may have, it has one or more internal operations.

    The Ground Track is an example of a passive class, that is, it does something only in response to an outside stimulus. Thus the only operations that pertain to it are those it offers to the outside world (viz., to be displayed at a certain scale, to be erased gradually, or to be cleared from memory). If it had been an active class, then it would have at least one additional operation (e.g., its own execution), because it would probably be implemented as an Ada task, which is an independently executing program unit, characterized by an execution of its own as well as services it provides to the outside world.

Method #2: Using Prior Documentation

2. If requirements documentation already exists for the system, the individual requirements state the operations which each class is required to perform.

    In the case of the Ground Track, a review of the System Specification indicates that the operations that the Ground Track is required to perform are the following:

    o   To display the flight path and the current location of the aircraft on the Cockpit CRT
    o   To erase the flight path of the aircraft starting with the oldest portions until signaled to stop
    o   To erase the entire Ground Track and remove it from memory entirely

    See the excerpts quoted above in Section 2.1.1.

2-7

Method #3: Using CIDs

3.   For each CID, pick any arrow that initiates an operation.

To illustrate the identification of operation Display, one may start with the arrow shown in Figure 2-3 from Graphic Display Controls to Ground Track. This is the starting point of an operation because the Ground Track is displayed in response to one of the push buttons on the Graphic Display Controls.

4.   Follow the sequence of the operation through to the end, grouping into the operation all other arrows included in that sequence.

What happens next? The Ground Track must retrieve the current position of the helicopter from Helicopter. Thus the arrow from Helicopter to Graphic Display Controls is subsumed into the current operation. What happens next? The Ground Track is displayed on the Cockpit CRT. Thus the arrow from Graphic Display Controls to Cockpit CRT is also subsumed into the current operation. Since this is the final result of the current operation, the cycle is finished.

5.   If there are any arrows left over, repeat steps 4 - 6 until all arrows have been grouped into operations.

There are further arrows left over. One would repeat the above steps until all arrows had been grouped into an operation.

2.2 OORA TECHNIQUES

The following sections supplement the OORA rules summarized above, focusing on the following techniques:

o   General techniques

o   Techniques for identifying lowest level classes

o   Techniques for identifying intermediate level classes

o   Techniques for identifying highest level classes

o   Techniques for refining classes

o   Techniques for relating classes to one another

o   Techniques for identifying operations

o   Techniques for relating classes and operations.

These techniques should be taken as a "tool set" from which the analyst may take what he/she needs for the particular application. The analyst is by no means obligated to use all of them, but some subset of them should prove useful in identifying classes and operations. A taxonomy of classes and operations is presentec .: Table 2-1 below.

TABLE 2-1
Taxonomy of Classes and Operations

I. Classes

    A. Lowest Level

        1. Primitive Data Types

        2. Hardware Interfares

        3. Non-Ada Code

        4. External Software

    B. Intermediate Level

    C. Highest Level

II. Operations

    A. Imported

    B. Exported

    C. Internal

2.2.1 GENERAL TECHNIQUES

Avoid communicating design information. The analyst must continually keep this dictum in mind, and must ask of every component of the requirements analysis whether it is actually required by the system. There is, after all, a rather clear distinction between a requirement and a design element: a requirement is something that the system cannot do without; a design element is not. To cite an earlier example, the

UH-1 must have a ground track; but it need not have a class of message buffers. The requirements are the constraints within which the designer is free to maneuver. They collectively constitute a fixed framework for the design.

Keep in mind the conceptual differences between a class, an attribute, and an operation. The benefits of object-oriented development can be fully realized only if it is indeed classes that are encapsulated in software modules, not attributes or operations disguised as classes. Conceptual clarity here is very important. Since the benefits of object-orientation are at stake, it is a far from trivial question of semantics. Attributes are properties; operations happen over time; classes are things that <u>have</u> attributes and <u>perform</u> operations. The distinction is abstract because, unlike the case of functional decomposition, the English language tends to obscure the distinctions between instances of these concepts. This is because it is far more common in English to turn attributes (which would naturally be expressed by adjectives and adjectival phrases and clauses) and operations (which would naturally be expressed as verbs) into nouns than to turn classes into adjectives or verbs. For example, it is possible to form abstract nouns out of the adjective "red" or the verb "move" by adding the appropriate suffixes--"redness" and "movement"--but impossible to change the noun "table" into a verb without changing its meaning. English tends to display functional distinctions on the surface, so that even a child (with some leading questions) could specify a functional breakdown of some process. But a child is far from able to utilize the subtle distinctions between classes, attributes, and operations, because to do so requires him/her to go beneath the surface grammar of the language and to apply these concepts in the abstract. This is one reason why object-oriented development is more difficult than function-based development.

Strive for specificity in the identification of classes and operations. The requirements analysis can be of greatest use to the eventual design, and in any case will be clearer in its own right, if the requirements analyst strives for specificity in the identification of classes and operations. The primary purpose of an analysis document is to convey information. More information is conveyed by a description that is specific than by one that is general. Moreover, a requirements document is clearer if slight variations among classes and operations are treated as separate classes and operations than if they are treated as a single class or operation whose processing is parameterized in various ways. For example, it is clearer to separate the requirements for the graph area of the Cockpit CRT into those for the Air Speed Graph and those for the Altitude Graph, because, although there are many similarities between the two kinds of graph, there are differences between them. Of course, from a design point of view it is desirable to generalize entities into generic entities to create powerful, reusable software components. But generalization is a function of design, not requirements. The requirements analysis must describe the required details of the system.

Number all requirements for traceability. This has been mentioned before. A design will not be rigorously traceable to a requirements analysis unless each requirement is uniquely identified. Requirements can best be uniquely identified through some numbering system.

2.2.2 TECHNIQUES FOR IDENTIFYING LOWEST LEVEL CLASSES

Identify primitive data types. These are lowest level classes because collectively they constitute a common language for the entire system.

Locate hardware interfaces. Interfaces to hardware are lowest level classes in a different sense from primitive data types, for hardware defines the boundaries of a system.

Determine if any non-Ada code will be used in the system. If so, the interfaces to it will also be lowest level classes. Non-Ada code also determines the boundary of a system, but in a different sense from hardware interfaces: Whereas hardware defines the boundaries of a system, non-Ada code defines a boundary within the system between native and foreign language software.

Identify any other software external to the system. Interfaces to such software are frequently advantageous because external software, even if written in Ada, is not under the control of the developer, and hence portability cannot be insured unless there is an interface to it. For example, if the system is ported to another operating system, Text_IO may be implemented slightly differently in the new environment from the old. An interface to Text_IO can insure that the developer has control of the behavior of textual input/output, since the body of the interface can be changed from one environment to another to insure that it behaves in a consistent manner.

2.2.3 TECHNIQUES FOR IDENTIFYING INTERMEDIATE LEVEL CLASSES

Group functionally related objects. One of the simplest techniques for identifying intermediate classes is to group together functionally interrelated objects. As an example, suppose the system being modelled includes a bank of indicator lights, each of which is illuminated when a different condition is met. Suppose one of these lights is turned on when a certain lever is pulled. What is the most illuminating way of structuring this scenario from a software point of view? Although at a lower level the lights may be grouped together in a single class because the same I/O mechanism is used to turn on and off a light, at a higher level we must consider whether they have anything in common with one another functionally speaking. In this case all they have in common is the fact that they are all lights, but they are not

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functionally interrelated. A more revealing, but more subtle way of grouping low level objects together is to associate the one light with the lever at a higher level. The software representing this class can insure that these two entities are always kept in sync. Outside, these two entities can be regarded as one, and one never has to think about them again.

Identify what the software is supposed to simulate. Another method of identifying intermediate classes is to identify objects that are to be simulated. Software usually simulates something in the real world. The appropriate question to ask is, what is this software supposed to simulate? Hardware objects are easy to identify; they are at the hardware interface. But behind these objects are more abstract objects that the software is modelling. For example, suppose we have a system in which a lever and a dial jointly influence the value of an altitude indicator. What is the real world entity simulated by the requisite software? Obviously, we must have a software interface to the lever, the dial, and the altitude indicator. But that does not exhaust the processing involved. There must be processing software that takes the input from the lever and the dial and converts it to something usable by the altitude indicator. What is it in the real world that the lever and dial influence and that the altitude indicator reads? The answer is deceptively simple--the altitude. Therefore we need a software class modelling the altitude given the output of the lever and the dial, and having the capability to return the current value of the altitude.

View the system in layers of abstraction. Still another technique the analyst can use is to view a system in layers of abstraction, to build classes of greater functionality on top of classes of lesser functionality. This is particularly useful for complex problems like data base design. On the lowest level, input to and output from a data base can be viewed as streams of bits. On a higher level, this same information may have structure and look like arrays of records, for example. On the highest level the very same data may look like data base commands and responses to queries. In the extreme case, each of these classes may contain exactly the same information at the bit level, but they are indeed three separate classes. Each level of abstraction adds functionality to the previous level.

2.2.4 TECHNIQUES FOR IDENT · ¡ ¨ G HIGHEST LEVEL CLASSES

Determine which classes provide no services to any others. One highest level class is the system itself. If the system is a truly hierarchical one, this class would have but one operation--execute. It would be represented in Ada by a stand-alone procedure that would be the main program. It is important to recognize, however, that a system may have more than one highest level class. This would occur if two conditions were met:

o   The system was comprised of more than one independently executing process.

o   More than one of these processes provided no services to the external world.

Basically, a system with more than one main process would contain more than one highest level class. This could be implemented with either multiple main programs or concurrently executing tasks.

2.2.5 TECHNIQUES FOR REFINING CLASSES

If two classes have both the same attributes and the same operations, combine them into one class. A class was defined earlier as an entity that is characterized by a set of attributes and/or a set of operations. Thus if two classes have the same attributes and operations, there is no way to distinguish them. Hence, they are not really two classes at all, but the same class.

Verify that the functionality of the system is sensibly distributed among the classes that have been identified. In any system there are many static entities that could be identified as classes for an object-oriented design. But not all these entities may be equally useful. An entity is interesting from a software point of view only if it is robust, if it "takes a bite out of the world." For example, a class which is built on top of another class but which does nothing but pass calls through to the lower level class is not an interesting software entity. Since it does nothing interesting, the system can do without it.

2.2.6 TECHNIQUES FOR RELATING CLASSES TO ONE ANOTHER

Classes are connected by cause-and-effect, not part-whole, relations. It is important to realize that the world can be divided up in many ways, and that the way the world appears to be on the surface may not be the most illuminating from the point of view of software development. If a class is used to simply group together other classes, and so contains no operations over and above the operations of its components, it is not an interesting software unit. Instead, classes should be causally related. Proponents of OOD are usually misleading on this score in suggesting that software classes model real-world objects in a part-whole manner. But anyone who has tried object-oriented development will realize that designing a system is not as simple as, say, looking at a car engine and jotting down its components, and then jotting down the components of these components, and so forth. That is because useful classes are causally related, and causal relationships are not as obvious as part-whole relations.

When analyzing the connection between two classes, consider the possibility that the flow of control may be in either direction. This is a technique for removing design bias from the requirements analysis. It is easy for the analyst to unconsciously assume a certain flow of control, which can then creep into the requirements document. But flow of control is almost always a design decision. Consciously looking at the relation between two classes from both directions (no matter how ridiculous one of the two may seem) helps to keep the analysis control-neutral. It is not the analyst's business to exclude control flow alternatives from the start, even by implication. What may seem absurd during the requirements phase may, on fuller consideration by the designer, turn out to be the best alternative.

Specify input and output at the class level, not the operation level. The reader will note that this rule is exemplified in the present document by the presence of imported and exported data lists. The advantages of this technique are twofold: First, the analyst thereby avoids prejudicing the flow of control. The analyst leaves it unspecified whether class A is sending data to class B, or whether class B is getting the data from class A. Who calls whom is an implementation question. Furthermore, following this rule gives the designer the option of separating operations that communicate with other classes from operations that actually process data. For example, an operation may need a certain data item from another class. But how is it to get it? Is it passed as a parameter either through calling an operation in the other class or being called by it? Or is the data item retrieved by an independent operation and stored for use by the operation in question, which now becomes an operation (such as a task) internal to the class? The designer should be free to choose between these alternatives.

2.2.7 TECHNIQUES FOR IDENTIFYING OPERATIONS

Ask what services a class provides to the outside world. These services are the class's exported operations.

Ask what operations a class requires to do its job. These are the class's imported operations. For example, a linked list package would require an ordering operation if the list is to be maintained in sorted order.

Determine if there are any operations a class performs in its own right. These would be operations that are internal to the class. This is the case of all classes whose objects are separately executing processes (Ada tasks and main programs). These classes include at least one operation which neither provides a service to the outside world nor is imported from the outside world. In this respect these classes are very different from those which do something only upon being stimulated from outside.

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2.2.8 TECHNIQUES FOR RELATING CLASSES AND OPERATIONS

Associate an operation with the affected, not the affecting, class. An operation is associated with the class whose state it either changes (if it is a constructor) or returns (if it is a selector). In other words, the operation is not associated with the class that actually performs the operation; in Ada terms, a given subprogram or entry is not associated with the entity that actually calls the subprogram or entry. If class A does something to class B, the operation that A does to B is associated with B, not A. Likewise, if A reads B's state, the read operation is associated with B, not A.

Data transformations belong in the hardware-software interface. In general, the analyst should avoid dictating where transformations are to take place. The only required transformations in a system lie at the interfaces. A common software design problem is whether, if A needs x and B has y, B should convert y to x and pass it to A, or A should receive y from B and convert it to x. In the case of data transformations at the hardware-software interface, however, the question does not really arise, because the purpose of a hardware-software interface is to convert between software and hardware rerpresentations of data.

Express operations as processing requirements. Doing this gives maximum flexibility to the designer. In the design phase the designer may see fit to group certain processing requirements together into a single operation. Whether and how to group them is a design question, however, and should be left as an open question by the requirements analysis.

Specify processing requirements at the class level, not at the operation level. If processing requirements are attached to operations, it is almost impossible to avoid expressing them in terms of algorithms. But writing algorithms should be a matter of design, not requirements analysis. Attaching procesing requirements to classes rather than operations removes this temptation; and the result is more likely to be a set of requirements that express the what, not the how.

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3 ENGINEERING REQUIREMENTS

The main part of this document is Section 3.2, which describes the CSCI capability requirements. Sections 3.1 and 3.3 describe the external and internal interface requirements respectively. Finally, Section 3.4 is a catalogue of CSCI data elements.

3.1 CSCI EXTERNAL INTERFACE REQUIREMENTS

The following describes the interface between the Instructor Operator Station and the hardware. The Instructor Operator Station controls and monitors the behavior of the Trainee Station by means of the following control panels:

- Mode Controls
- Graphic Display Controls
- Playback Controls
- Malfunction Controls
- Flight Controls
- Problem Controls
- AID Controls
- Communication Controls
- Cockpit Display Select Controls
- Cockpit Select Controls
- Cockpit CRT
- Auxiliary Information Display

The AID Controls are in turn comprised of the following control panels:

- Display Select Controls
- Display Area Select Controls
- Display/Edit Format Select Controls
- Transfer Cockpit Area to Edit Area Controls
- Flight Parameter Controls

EXTERNAL INTERFACES

	Data	Hardware Class	Software Class
1.	SEMI AUTO State	SEMI AUTO push button	Mode Controls
2.	GTRK 12.5 State	GTRK 12.5 X 12.5 push button	Graphic Display Controls
3.	GTRK 25 State	GTRK 25 X 25 push button	Graphic Display Controls
4.	GTRK 100 State	GTRK 100 X 100 push button	Graphic Display Controls
5.	GND TRK ERASE State	GND TRK ERASE push button	Graphic Display Controls
6.	PLOT AREA RCL State	PLOT AREA RCL push button	Graphic Display Controls
7.	GCA COMM State	GCA COMM push button	Graphic Display Controls
8.	AREA SEL Value	AREA SEL thumbwheel switch	Graphic Display Controls
9.	FULL SCALE AS State	FULL SCALE AS push button	Graphic Display Controls
10.	FULL SCALE ALT State	FULL SCALE ALT push button	Graphic Display Controls
11.	RESET State	RESET push button	Playback Controls

12. MIN SEL Value	MIN SEL thumbwheel switch	Playback Controls
13. PAUSE State	PAUSE push button	Playback Controls
14. IN PROG State	IN PROG push button	Playback Controls
15. SLOW TIME State	SLOW TIME push button	Playback Controls
16. INSR State	INSR push button	Malfunction Controls
17. INHB RMV State	INHB RMV push button	Malfunction Controls
18. SEL Value	SEL thumbwheel switch	Malfunction Controls
19. CRASH OVRD State	CRASH OVRD push button	Flight Controls
20. PROB FRZ State	PROB FRZ push button	Flight Controls
21. PROB RESET State	PROB RESET push button	Flight Controls
22. AUTO COPILOT State	AUTO COPILOT push button	Flight Controls
23. ACK STUD State	ACK STUD push button	Flight Controls
24. Problem Status Area State	Screen	Cockpit CRT
25. Map Plot Area State	Screen	Cockpit CRT
26. Air Speed Graph Area State	Screen	Cockpit CRT
27. Altitude Graph Area State	Screen	Cockpit CRT
28. MALF State	MALF push button	Problem Controls
29. PROB Value	PROB thumbwheel switch	Problem Controls
30. DEMO Value	DEMO thumbwheel switch	Problem Controls
31. FRZ State	FRZ push button	Problem Controls
32. CONT State	CONT push button	Problem Controls
33. AUTO COPILOT State	AUTO COPILOT push button	Problem Controls
34. IN PROG State	IN PROG push button	Problem Controls
35. SLOW State	SLOW push button	Problem Controls
36. RESET State	RESET push button	Problem Controls
37. INSTR CALL State	INSTR CALL push button	Problem Controls
38. Control Sequence	Keypad	Numeric Keypad
39. CROSS CNTRY State	CROSS CNTRY push button	AID Controls
40. AREA State	AREA push button	AID Controls
41. GCA State	GCA push button	AID Controls
42. CKPT 1 AREA State	CKPT 1 AREA push button	AID Controls
43. CKPT 2 AREA State	CKPT 2 AREA push button	AID Controls
44. CKPT 3 AREA State	CKPT 3 AREA push button	AID Controls
45. CKPT 4 AREA State	CKPT 4 AREA push button	AID Controls
46. EDIT AREA State	EDIT AREA push button	AID Controls
47. FAIL State	FAIL push button	AID Controls
48. INIT COND State	INIT COND push button	AID Controls
49. FLT PRMTR State	FLT PRMTR push button	AID Controls
50. RADIO NAV State	RADIO NAV push button	AID Controls
51. STORED PLOTS State	STORED PLOTS push button	AID Controls
52. 1 State	1 push button	AID Controls
53. 2 State	2 push button	AID Controls
54. 3 State	3 push button	AID Controls
55. 4 State	4 push button	AID Controls
56. FLT PRMTR FRZ State	FLT PRMTR FRZ push button	AID Controls
57. FLT PRMTR RSTRE State	FLT PRMTR RSTRE push	AID Controls

button

58.	Cockpit #1 Display Area State	Screen	Auxiliary Information Display
59.	Cockpit #2 Display Area State	Screen	Auxiliary Information Display
60.	Cockpit #3 Display Area State	Screen	Auxiliary Information Display
61.	Cockpit #4 Display Area State	Screen	Auxiliary Information Display
62.	Cockpit #1 Edit Area State	Screen	Auxiliary Information Display
63.	Cockpit #2 Edit Area State	Screen	Auxiliary Information Display
64.	Cockpit #3 Edit Area State	Screen	Auxiliary Information Display
65.	Cockpit #4 Edit Area State	Screen	Auxiliary Information Display
66.	UHF State	UHF push button	Communication Controls
67.	VHF FM State	VHF FM push button	Communication Controls
68.	VHF NAV State	VHF NAV push button	Communication Controls
69.	ICS State	ICS push button	Communication Controls
70.	COMM AUDIO NET State	COMM AUDIO NET push button	Communication Controls
71.	MON STUD HDST State	MON STUD HDST push button	Communication Controls
72.	ATC State	ATC push button	Communication Controls
73.	1 State	1 push button	Cockpit Display Select Controls
74.	2 State	2 push button	Cockpit Display Select Controls
75.	3 State	3 push button	Cockpit Display Select Controls
76.	4 State	4 push button	Cockpit Display Select Controls
77.	1 State	1 push button	Cockpit Select Controls
78.	2 State	2 push button	Cockpit Select Controls
79.	3 State	3 push button	Cockpit Select Controls
80.	4 State	4 push button	Cockpit Select Controls

3.1.1 HARDWARE CONFIGURATION

The UH-1 Flight Simulator (FS) System is shown in Figure 3-1. It consists of four trainee stations, each an independently operated helicopter cockpit mounted on a five degree of freedom motion platform. A centralized Instructor Operator Station (IOS) sets up each cockpit for simulated flight. Each half of the IOS controls two cockpits. This section describes the actual hardware configuration of the system. It is divided into a description of the Instructor Operator Station (IOS) and the Trainee Station. Each of these is broken down into its component panels or other parts to provide an overview of the hardware controls and display devices that interface with the software.
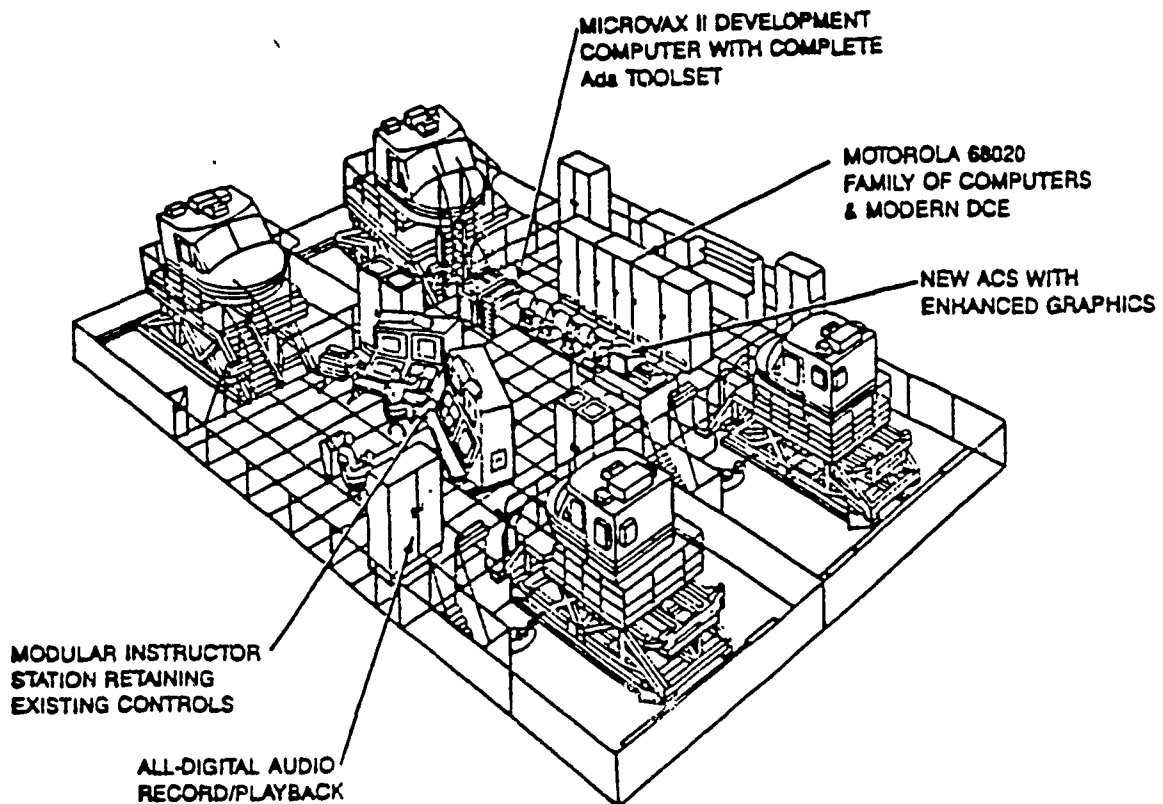
Figure 3-1. UH-1 Flight Simulator System.

3.1.1.1 Instructor Operator Station

The IOS consists of an array of controls and displays of information on the status and progress of training with each cockpit. The IOS runs in a split configuration with IOS-A controlling cockpits 1 and 2 and IOS-B controlling cockpits 3 and 4. Each part is capable of running independently. Figure 3-2 denotes the configuration of the real-time computer system. Each IOS segment consists of the following displays:

- One overhead panel which repeats the flight and engine instrument readings of the selected cockpit.

- Two CRTs, each of which display a trainee's flight path on a gaming area map, along with airspeed and altitude histories, and tabular information describing the status of training underway.

- One CRT data display used in connection display and modification of problem parameters.

The controls at the IOS also permit communication with personnel in each cockpit as well as with various information displays and printout devices.
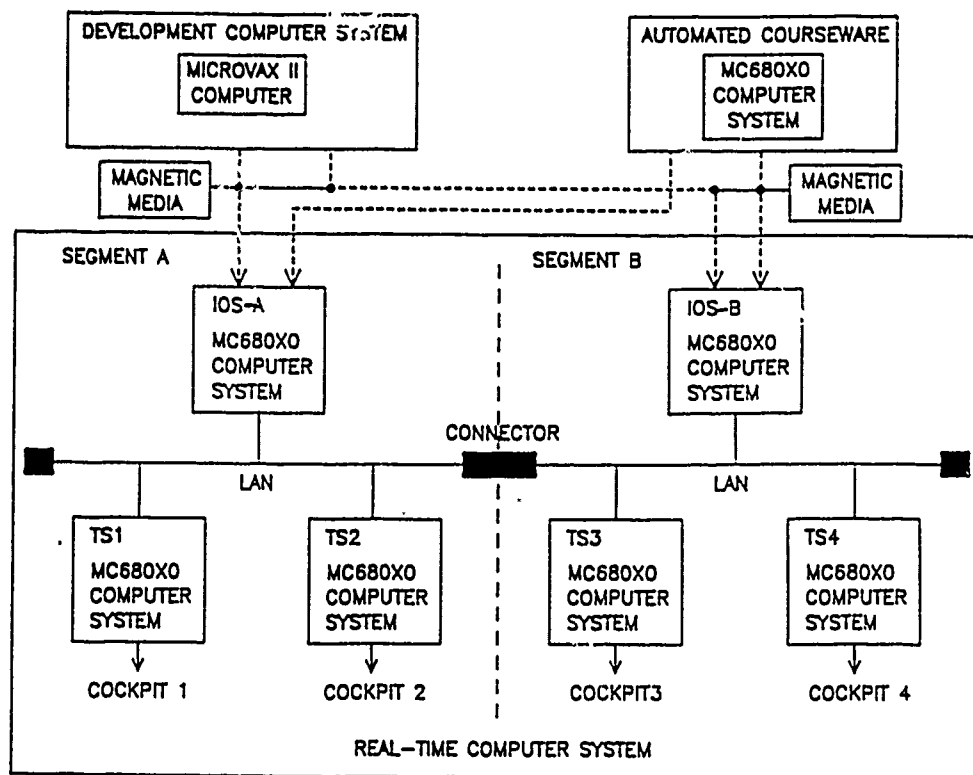
Figure 3-2. Configuration of the Real-Time Computer System.

Figure 3-3 illustrates the location and relative size of the IOS panels and CRT displays. Panels and displays are described in subsequent sections as follows:

- Trainee Station Control Panel
- Auxiliary Information Display Control Panel
- Communication Control Panel
- Timer/Display Control Panel
- Cockpit CRT
- Auxiliary Information Display
- Cockpit Indicator Display
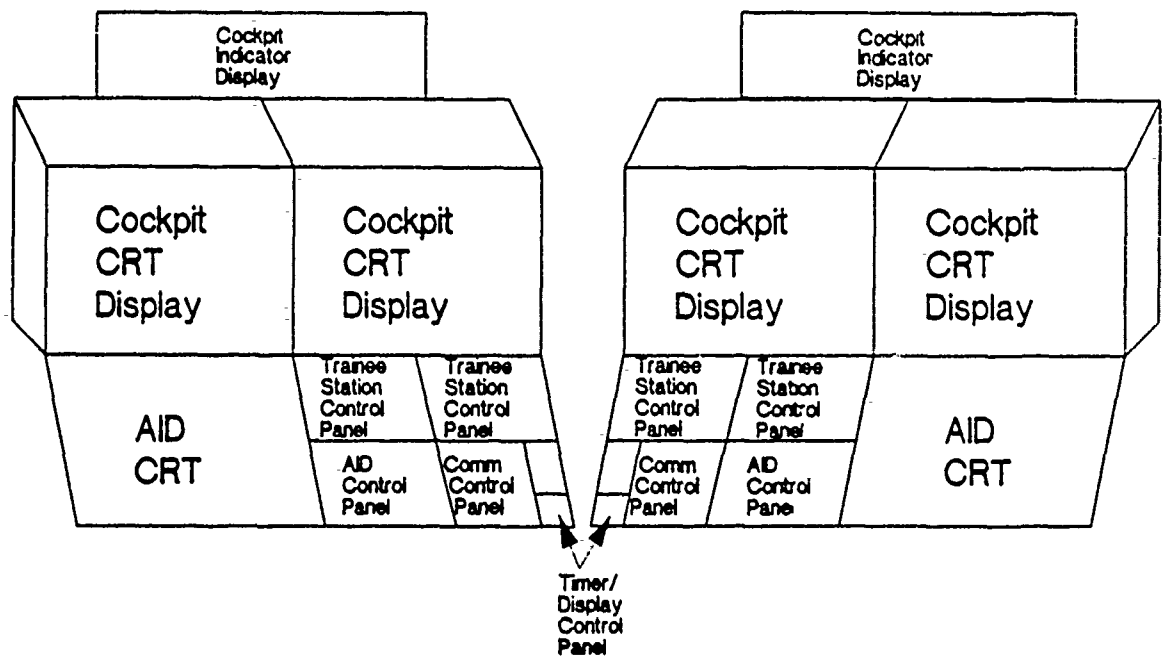
Figure 3-3. IOS Panels and CRT Displays.

3.1.1.1.1 Trainee Station Control Panel

There are four Trainee Station Control Panels. The control panels for Trainee Stations 1 and 2 are located across the top of IOS-A. The control panels for Trainee Stations 3 and 4 are located across the top of IOS-B. A diagram of the Trainee Station Control Panel is shown in Figure 3-4. Controls correspond to sections in the Hardware Interface as follows:

- Mode Controls (3.1.2.1)
- Graphic Display Controls (3.1.2.2)
- Playback Controls (3.1.2.3)
- Malfunction Controls (3.1.2.4)
- Flight Controls (3.1.2.5)

3.1.1.1.2 Auxiliary Information Display Control Panel

There are two Auxiliary Information Display (AID) Control Panels: One for Trainee Stations 1 and 2 on IOS-A and the other for Trainee Stations 3 and 4 on IOS-B. They are located on the lower left of IOS-A central console and the lower right of the IOS-B central control console. A diagram of the AID Control Panel is shown in Figure 3-5. The controls correspond sections in the Hardware Interface as follows:

- Numeric Keypad (3.1.2.8)
- AID Controls (3.1.1.9)

3.1.1.1.3 Communication Control Panel

There are two Communication Control Panels: one for Trainee Stations 1 and 2 on IOS-A and the other for Trainee Stations 3 and 4 on IOS-B. They are located on the lower middle of IOS-A central console and the lower middle of the IOS-B central control console. A diagram of the Communications Control Panel is shown in Figure 3-6. The left side of the panel is for trainee station 1 (or 3) and the right side is for trainee stations 2 (or 4). The controls correspond to the following section of the Hardware Interface:

- Communication Controls (3.1.2.11)

3.1.1.1.4 Timer/Display Control Panel

There are two Timer/Display Control Panels: one for Trainee Stations 1 and 2 on IOS-A and the other for Trainee Stations 3 and 4 on IOS-B. They are located on the lower right of IOS-A central control console and the lower left of the IOS-B central control console. A diagram of the Timer/Display Control Panel is shown in Figure 3-7. The controls correspond to the following section of the Hardware Interface as follows:

- Cockpit Display/Select Controls (3.1.2.12)
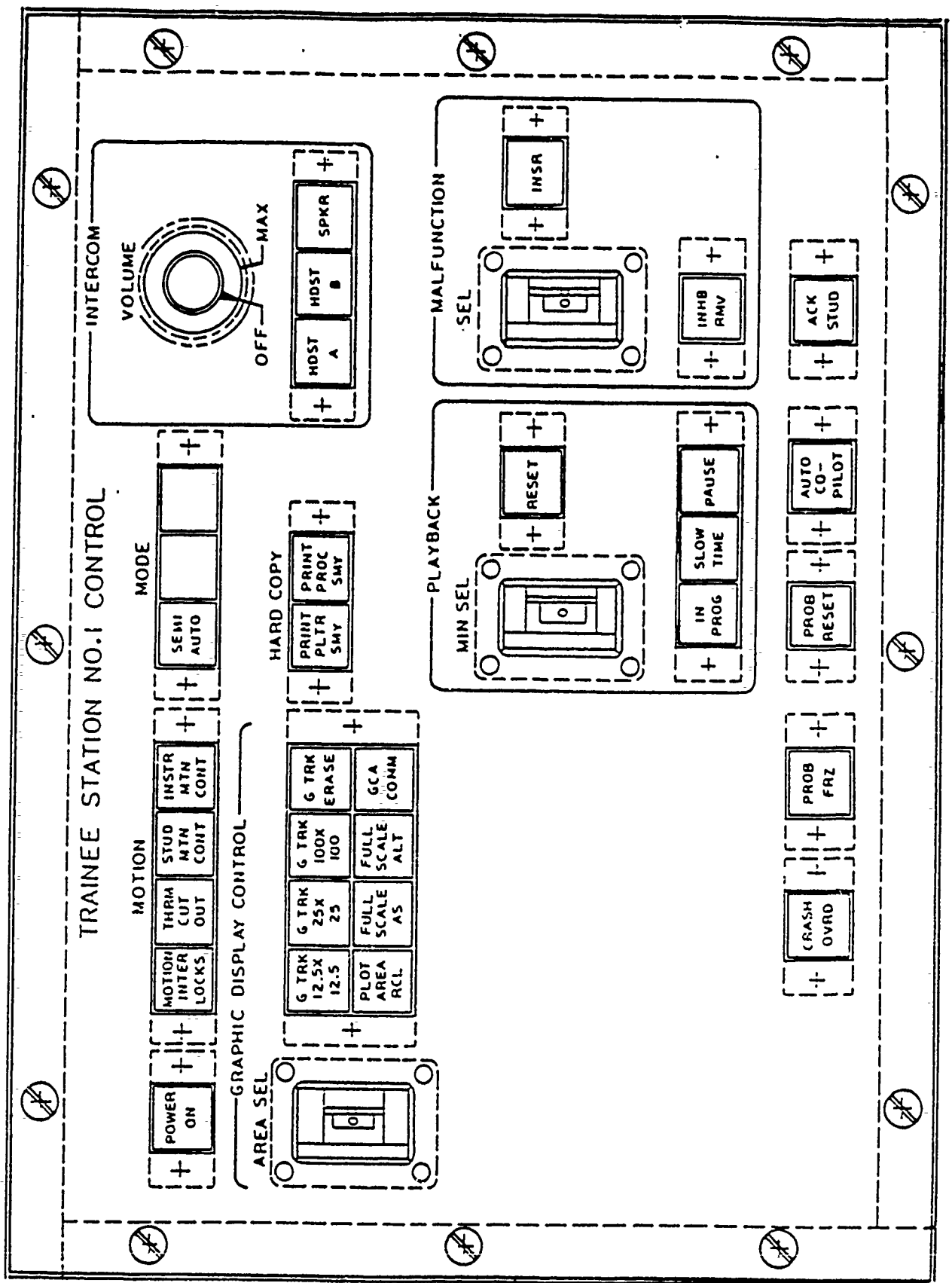
Figure 3-4. Trainee Station Control Panel.
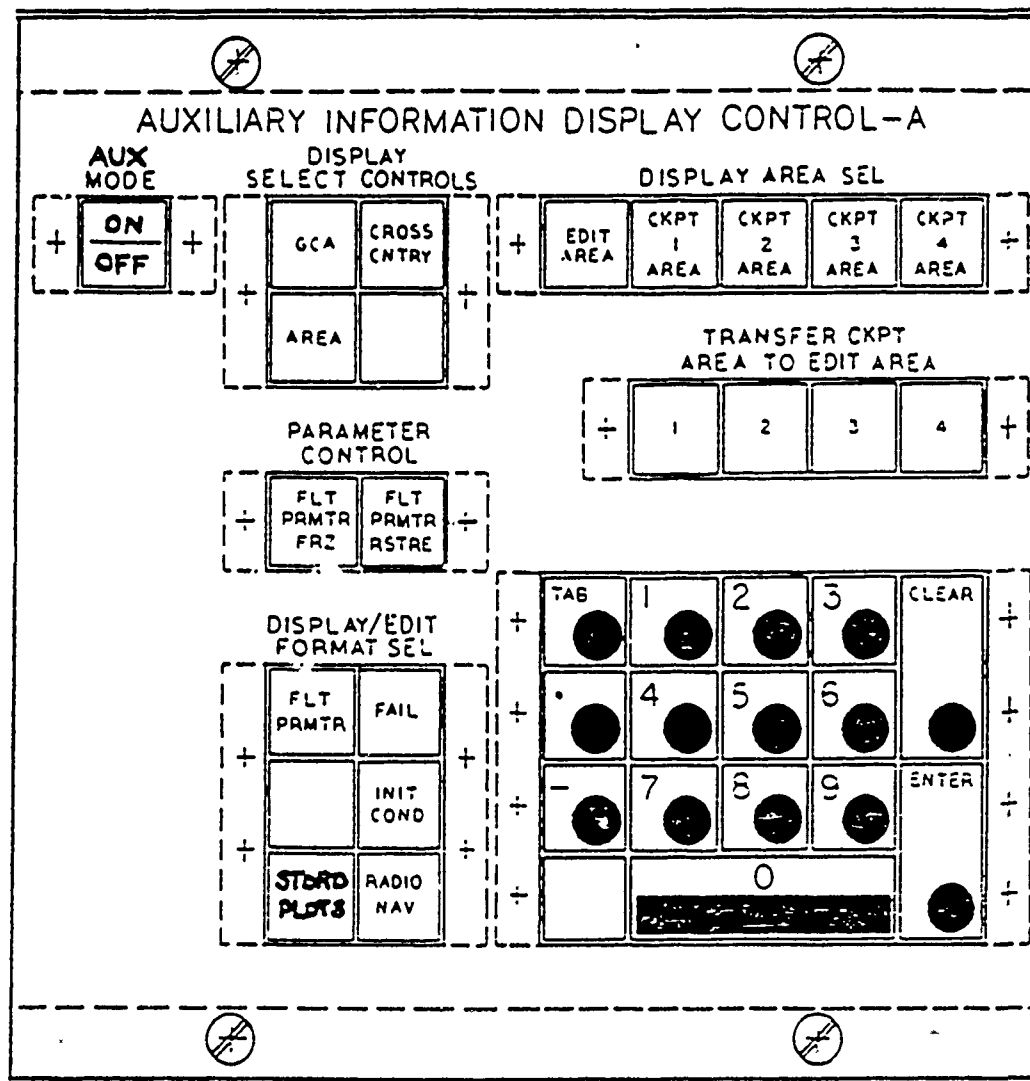
Figure 3-5. Auxilliary Information Display (AID) Control Panel.
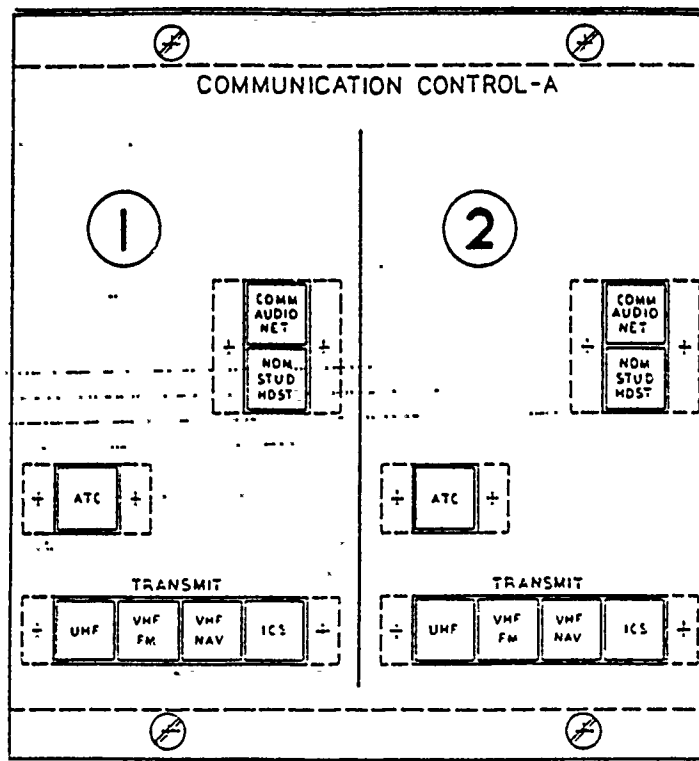
Figure 3-6. Communications Control Panel.
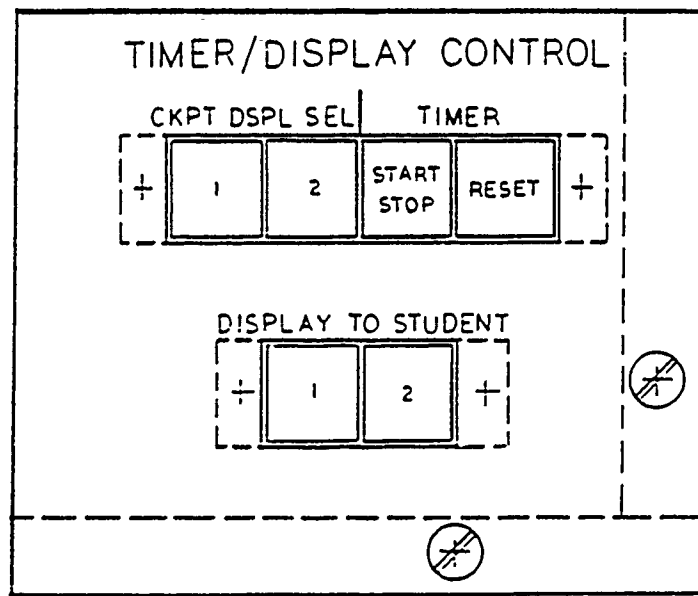
Figure 3-7. Timer/Display Control Panel.

3.1.1.1.5 Cockpit CRT

There are two Cockpit CRTs for each cockpit: one is located in the rear of the cockpit, and the other at the IOS. The CRTs for Trainee Stations 1 and 2 are located along the top of IOS-A. The CRTs for Trainee Stations 3 and 4 are located along the top of IOS-B. The display on both CRTs for a given cockpit are identical. Cockpit CRT corresponds to the following section of the Hardware Interface:

- Cockpit CRT (3.1.2.6)

3.1.1.1.6 Auxiliary Information Display CRT

There are two Auxiliary Information Display CRTs. The AID CRT for Trainee Stations 1 and 2 is located to the left of the central control console of IOS-A. The AID CRT for Trainee Stations 3 and 4 is located to the right of the central control console of IOS-B. In each case, the screen of the AID CRT is flush with the console. The AID corresponds to the following section of the Hardware Interface:

- Auxiliary Information Display (3.1.2.10)

3.1.1.1.7 Cockpit Indicator Display

There are two Cockpit Indicator Displays. The Cockpit Indicator Display for Trainee Stations 1 and 2 is located above the Cockpit CRTs for IOS-A. The Cockpit Indictor Display for Trainee Stations 3 and 4 is located above the Cockpit CRTs of IOS-B. A diagram of the Cockpit Indicator Display is shown in Figure 3-8. The components of the Cockpit Indicator Display correspond to sections in the Hardware Interface as follows:

- Cockpit Select Controls (3.1.2.13)

In addition, the Cockpit Indicator Display contains copies of the following instruments:

- Altitude Digital Readout
- Barometric Pressure Digital Readout
- Minutes of Fuel Remaining Digital Readout
- Course Selected Digital Readout
- Rotor RPM Linear Indicator
- Engine RPM Linear Indicator
- Torque Pressure Linear Indicator
- Gas Producer Linear Indicator
- Exhaust Gas Temperature Linear Indicator
- Airspeed Linear Indicator
- Vertical Velocity Linear Indicator
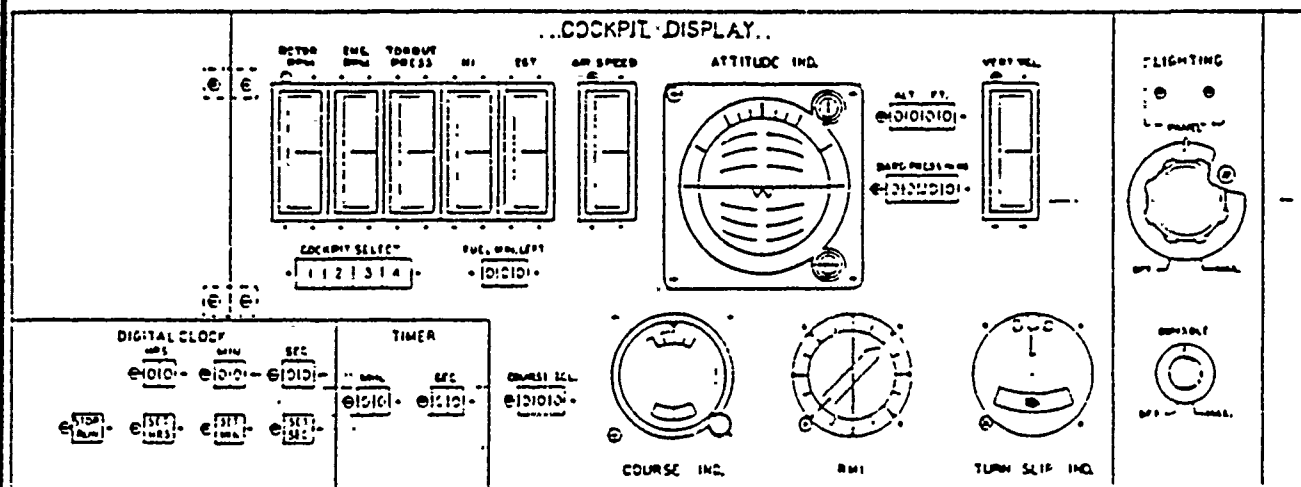
Figure 3-8. Cockpit Indicator Display.

3.1.1.2 Trainee Station

The Trainee Station is modelled after the cockpit of the UH-1 helicopter. The Trainee Station consists of the following components:

- Cockpit Instrument Panel
- Cockpit Pedestal
- Cockpit Overhead Console
- Control Loading System

Figure 3-9 illustrates the relative position of these components within the cockpit.
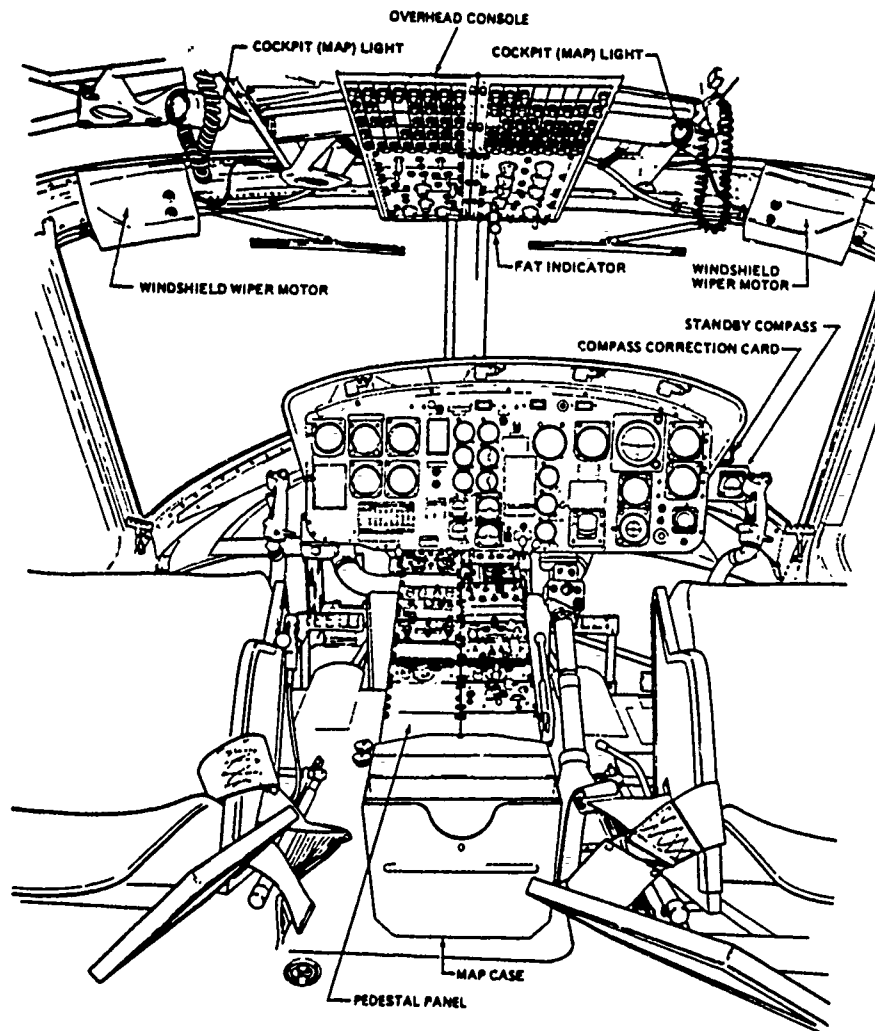
Figure 3-9. Trainee Station Crew Compartment.

3.1.1.2.1 Cockpit Instrument Panel

The Trainee Status Information Display is located on the Cockpit Instrument Panel. Figure 3-10 shows the Trainee Status Information Display. The diagram of the cockpit Instrument Panel is shown in Figure 3-11. The controls are cross referenced in the figure. The components of the Cockpit Instrument Panel are as follows:

- Turn and Slip Indicator
- Attitude Indicator
- Airspeed Indicator
- Dual Tachometer
- Free-Air Temperature Indicator
- Pressure Altimeter
- Vertical Velocity Indicator
- Transmission Oil Pressure Indicator
- Transmission Oil Temperature Indicator
- DC Voltmeter
- DC Loadmeter
- AC Voltmeter
- Exhaust Gas Temperature Indicator
- Torquemeter
- Gas Producer Tachometer
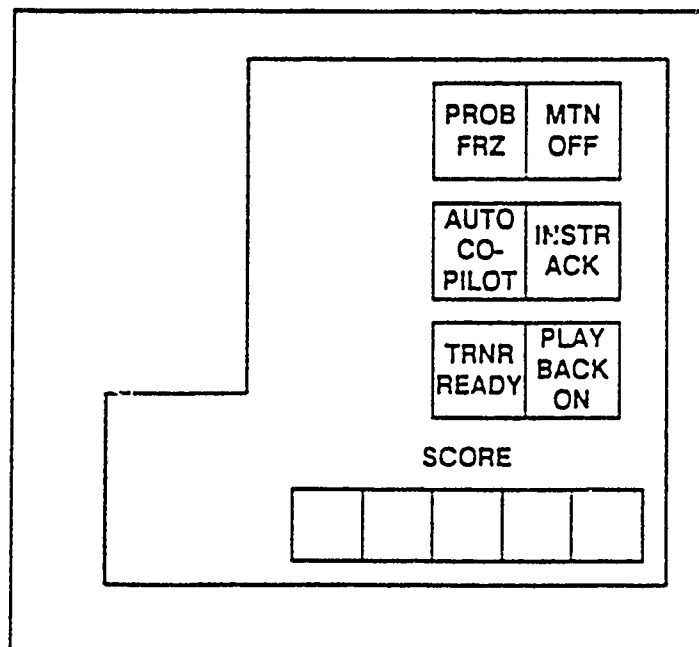
Figure 3-10. Trainer Status Information Display.
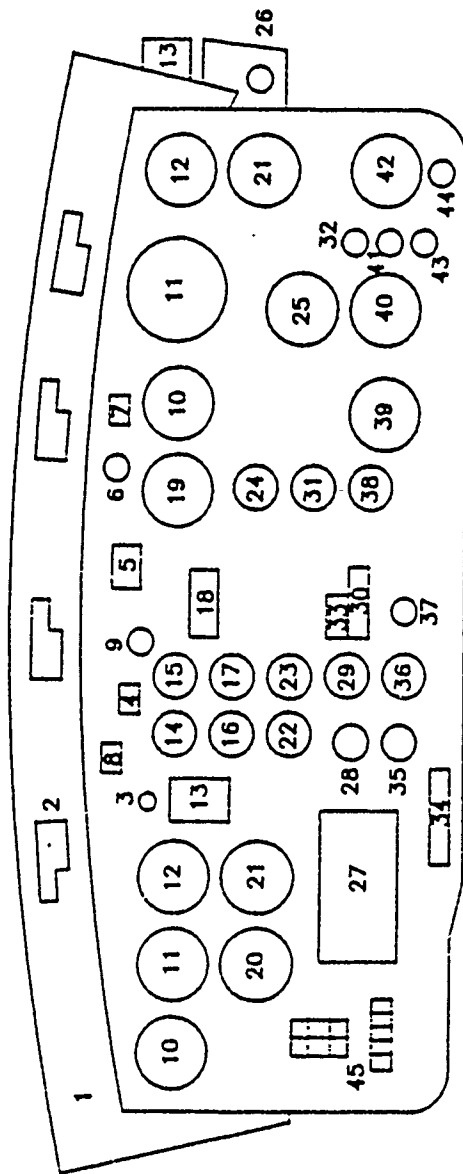
1. GLARE SHIELD
2. SECONDARY LIGHTS
3. ENGINE AIR FILTER LIGHT
4. MASTER CAUTION LIGHT
5. RPM WARNING LIGHT
6. FIRE DETECTOR TEST SWITCH
7. FIRE WARNING INDICATOR LIGHT
8. RADIO CALL DESIGNATOR
9. FUEL GAGE TEST SWITCH
10. AIRSPEED INDICATOR
11. ATTITUDE INDICATOR
12. PRESSURE ALTIMETER
13. COMPASS CORRECTION CARD HOLDER
14. FUEL PRESSURE INDICATOR
15. FUEL QUANTITY INDICATOR

16. ENGINE OIL PRESSURE INDICATOR
17. ENGINE OIL TEMPERATURE INDICATOR
18. CARGO CAUTION DECAL
19. DUAL TACHOMETER
20. RADIO MAGNETIC INDICATOR
21. VERTICAL VELOCITY INDICATOR
22. TRANSMISSION OIL PRESSURE INDICATOR
23. TRANSMISSION OIL TEMP INDICATOR
24. TORQUEMETER INDICATOR
25. RADIO MAGNETIC INDICATOR
26. STANDBY COMPASS
27. OPERATING LIMITS DECAL
28. MAIN GENERATOR LOADMETER
29. DC VOLTMETER
30. ENGINE CAUTION DECAL

31. GAS PRODUCER TACHOMETER INDICATOR
32. MARKER BEACON LIGHT
33. ENGINE INSTALLATION DECAL
34. TRANSMITTER SELECTOR DECAL
35. STANDBY GENERATOR LOADMETER
36. AC VOLTMETER
37. COMPASS SLAVING SWITCH
38. EXHAUST GAS TEMPERATURE INDICATOR
39. TURN AND SLIP INDICATOR
40. OMNI INDICATOR
41. MARKER BEACON SENSING SWITCH
42. CLOCK
43. MARKER BEACON VOLUME CONTROL
44. CARGO RELEASE ARMED LIGHT
45. TRAINEE INFORMATION DISPLAY

Figure 3-11. Cockpit Instrument Panel.

3-15

- Engine Oil Pressure Indicator
- Engine Oil Temperature Indicator
- Marker Beacon Controls
- Course Indicator
- Radio Magnetic Indicator
- TACAN Distance Indicator

The Trainee Information Display is discussed in the corresponding sections of the Hardware Interface:

- Problem Controls (3.1.2.7)
- Playback Controls (3.1.2.3)
- Flight Controls (3.1.2.4)

3.1.1.2.2 Cockpit Pedestal

Figure 3-12 illustrates the relative position of components located on the Cockpit Pedestal. The Problem Control Panel is located on the cockpit pedestal and is shown in Figure 3-13. Components of the Cockpit Pedestal are discussed in corresponding sections of the Hardware Interface as follows:

- Problem Controls (3.1.2.7)

In addition, the Cockpit Pedestal includes the following instruments:

- FM Radio
- UHF Radio
- VHF Radio
- VHF Navigation Radio
- ADF Radio
- TACAN Radio
- Transponder
- Signal Distribution Controls
- Caution Lights
- Engine Controls

3.1.1.2.3 Cockpit Overhead Console

Figure 3-14 illustrates the relative positions of components located on the Cockpit Overhead Console. Components of the Cockpit Overhead Console are as follows:

- Power Controls
- Circuit Breakers

3.1.1.2.4 Control Loading System

Figure 3-15 illustrates two components of the Control Loading System: 1) collective and 2) cyclic. Components of the Control Loading System are as follows:

- Collective
- Cyclic
- Pedals
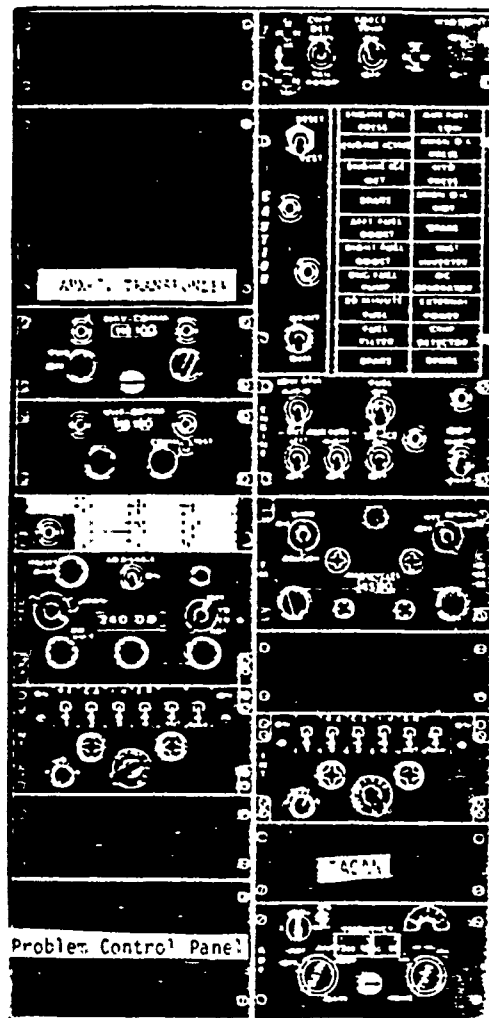
Figure 3-12. Cockpit Pedestal.

AUTO PROG CONTROL

- MODE -   - SELECT -

DEMO   PROB   DEMO   PROB

CONT
ADV
SLOW
RESET

IN PROG
FRZ

```
  ┌─────────────┐
  │ 3 │ 1 │ 0 │
  └─────────────┘
```

	MALF

MTN	AUTO CO-PILOT		INSTR CALL
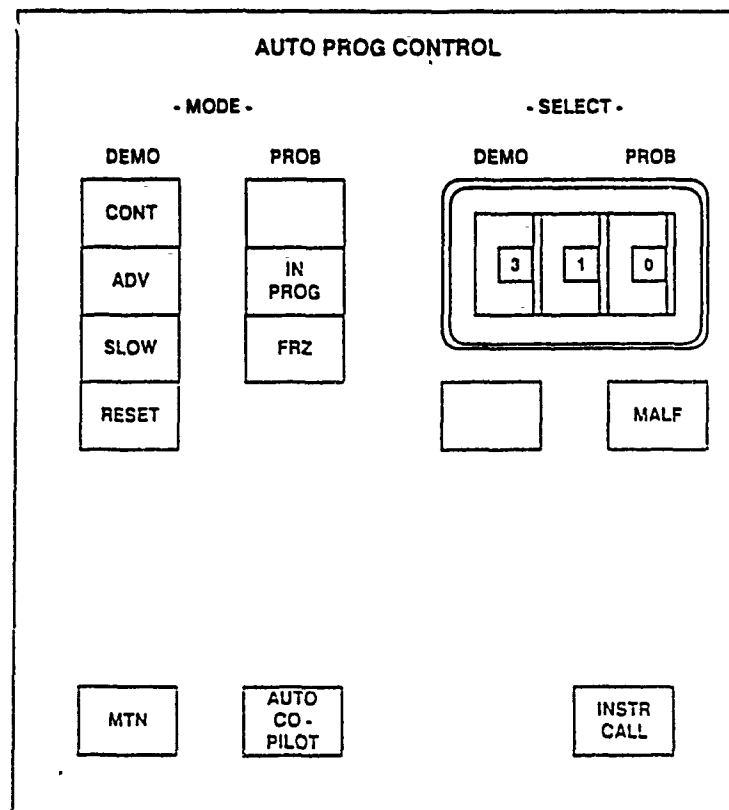
Figure 3-13. Problem Control Panel.
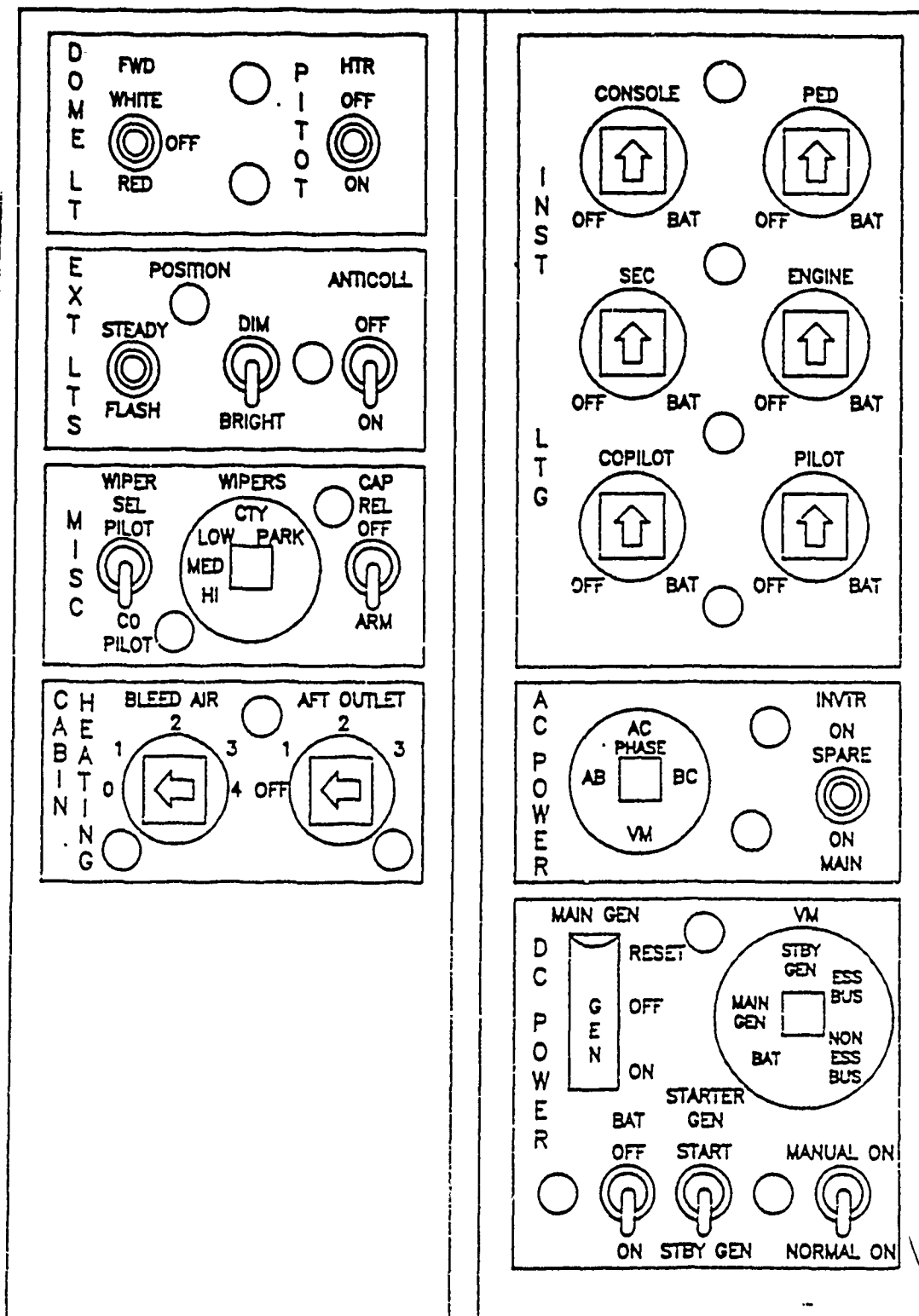
Figure 3-14. Cockpit Overhead Console.
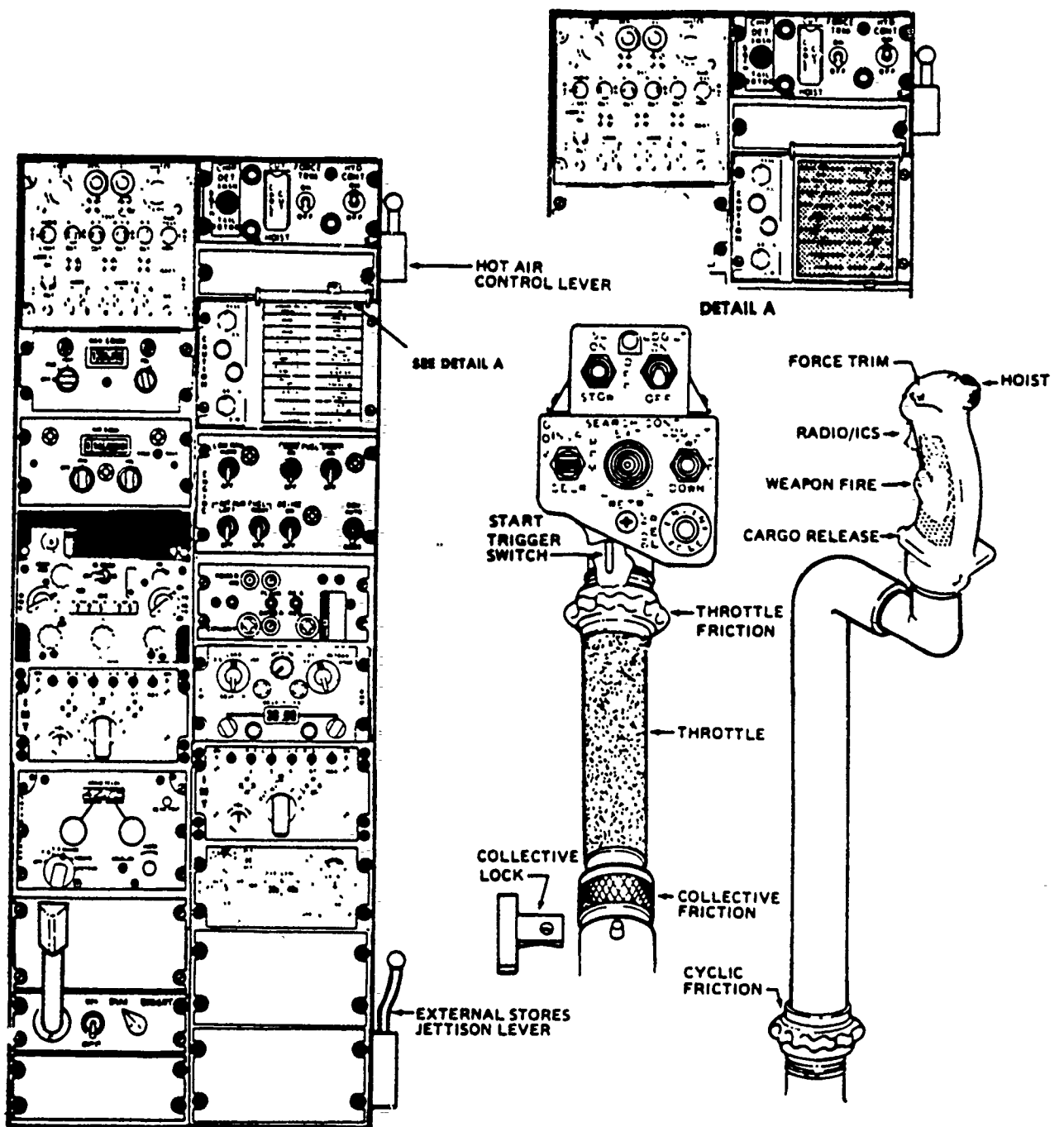
Figure 3-15. Components of the Control Loading System.

3.1.2 HARDWARE INTERFACE

This subsystem includes all software classes that receive input from or send output to a hardware device.

CLASSES

Trainee Station Control Panel

1. Mode Controls
2. Graphic Display Controls
3. Playback Controls
4. Malfunction Controls
5. Flight Controls
6. Cockpit CRT

Cockpit Pedestal

7. Problem Controls

Auxiliary Information Display Control Panel

8. Numeric Keypad
9. AID Controls
10. Auxiliary Information Display

Communication Control Panel

11. Communication Controls

Timer/Display Control Panel

12. Cockpit Display Select Controls

Cockpit Indicator Display

13. Cockpit Select Controls

Trainee Station Control Panel

3.1.2.1 Mode Controls

The Mode Controls determine the mode the Trainee Station will operate in. Currently, the only allowed mode is semiautomatic. The Mode Controls class is depicted in Figure 16.

ATTRIBUTES

    1. SEMI AUTO State

IMPORTED DATA

    <none>

EXPORTED DATA

    1. Mode of Operation

PROCESSING

    Exported Data

    1. Mode of Operation is always Semiautomatic.

    Push Buttons

    2. The SEMI AUTO push button is extinguished while the trainer is off.
    3. The SEMI AUTO push button is set to flash while depressed until the trainer has completed initialization.
    4. When the trainer has completed initialization, the SEMI AUTO push button is changed from a flashing to a constant state.

INTERFACES

    1. The system is started when SEMI AUTO State is On. When this happens, the following displays appear on the Cockpit CRT:

        • the Problem Status Display with the default map scale
        • the Air Speed Graph at normal size
        • the Altitude Graph at normal size
        • a Cross Country Map at the default scale

Hardware

1: SEMI AUTO State
2: SEMI AUTO State
3: Mode of Operaticn

1

2

Mode
Controls

3

Problem
Status
Display
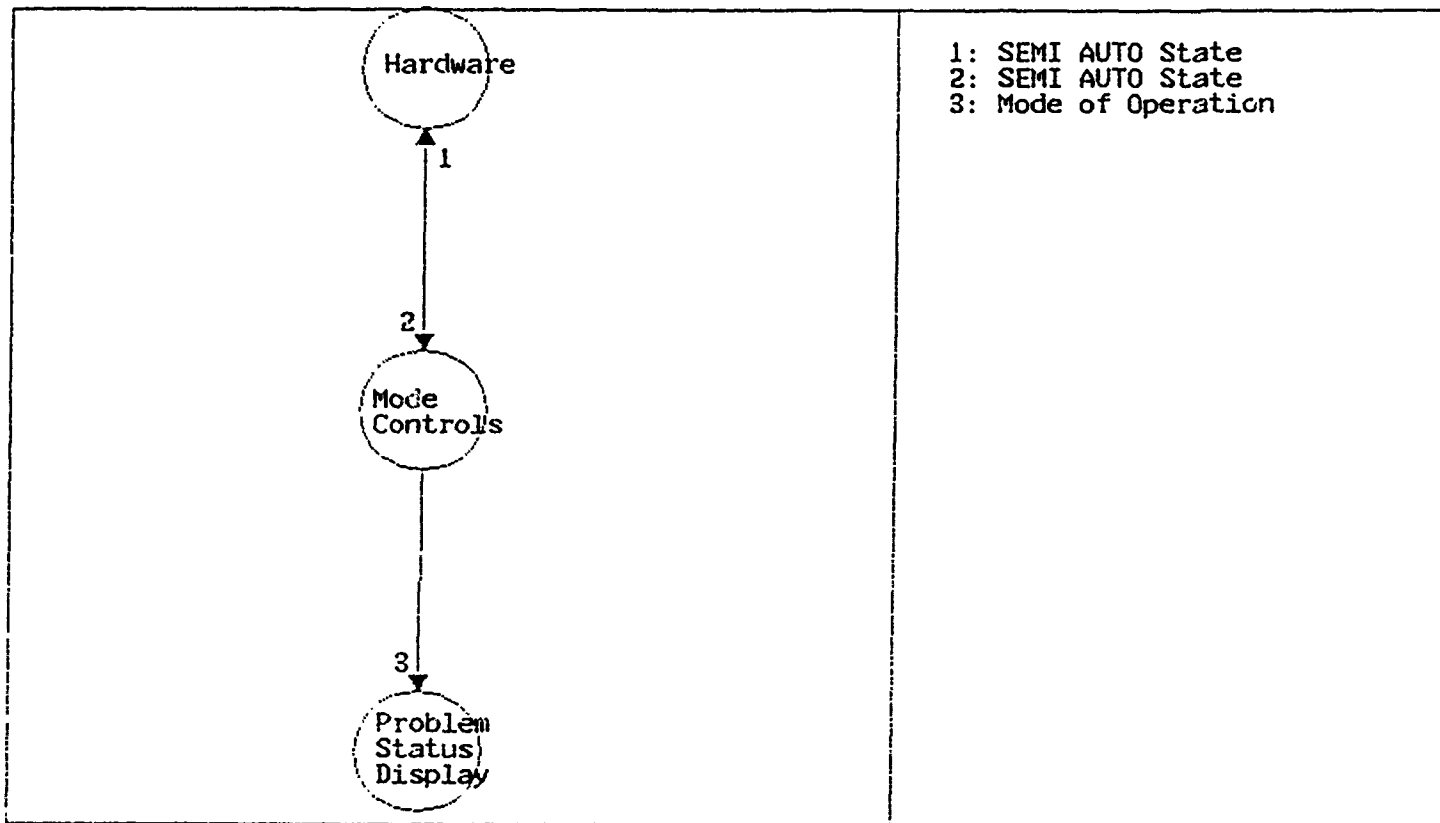
Figure 3-16. Mode Controls CID.

3.1.2.2 Graphic Display Controls

The Graphic Display Controls control the display of the simulated flight for the associated trainee station on the Cockpit CRT. The Graphic Display Controls class is depicted in Figure 17.

ATTRIBUTES

1. GTRK 12.5 X 12.5 State
2. GTRK 25 X 25 State
3. GTRK 100 X 100 State
4. PLOT AREA RCL State
5. GCA COMM State
6. GND TRK ERASE State
7. FULL SCALE AS State
8. FULL SCALE ALT State
9. AREA SEL Value

IMPORTED DATA

<none>

EXPORTED DATA

1. Cross Country Map Scale
2. Approach Map Area
3. GCA Graph Scale

PROCESSING

Exported Data

1. If the GTRK 12.5 X 12.5, GTRK 25 X 25, or GTRK 100 X 100 push button is depressed, Cross Country Map Scale is set accordingly.
2. Cross Country Map Scale is set to 100 x 100 if the PLOT AREA RCL push button is depressed and AREA SEL Value is equal to 0.
3. Approach Map Area is set according to AREA SEL Value if the PLOT AREA RCL push button is depressed and AREA SEL Value is greater than 0.
4. GCA Graph Scale is set to 0 to 2.5 if AREA SEL Value is equal to 1 and the GCA COMM push button is depressed.
5. GCA Graph Scale is set to 0 to 10 if AREA SEL Value is equal to 2 and the GCA COMM push button is depressed.

Push Buttons

6. The GTRK 12.5 X 12.5, GTRK 25 X 25, GTRK 100 X 100, FULL SCALE AS, FULL SCALE ALT, and GCA COMM push buttons are illuminated when depressed.
7. The GTRK 12.5 X 12.5, GTRK 25 X 25, GTRK 100 X 100, FULL SCALE AS, FULL SCALE ALT, and GCA COMM push buttons are extinguished when the display appears.
8. When depressed, the PLOT AREA RCL push button is set to flashing until the display appears on the screen.
9. When the display appears on the screen, the PLOT AREA RCL push button is extinguished.

10. When depressed, the GND TRK ERASE push button becomes illuminated if currently extinguished, and extinguished if currently illuminated.

INTERFACES

1. If PLOT AREA RCL State is On and AREA SEL Value is equal to 0, then the following displays appear on the Cockpit CRT:

   • a Cross Country Map at the default scale
   • a Ground Track
   • any Visual Error Alerts
   • the default map scale in the Problem Status Display

2. If PLOT AREA RCL State is On and AREA SEL Value is greater than 0, then the Approach Map corresponding to that value is displayed on the Cockpit CRT.

3. If GTRK 12.5 X 12.5, GTRK 25 X 25, or GTRK 100 X 100 State is On, then the following displays appear on the Cockpit CRT:

   • a Cross Country Map at the corresponding scale
   • the map scale in the Problem Status Display

4. If GND TRK ERASE State is On while erasing is not in progress, then the following items are erased in the following order:

   • any Visual Error Alerts
   • the Ground Track

5. If GND TRK ERASE State is On while erasing is in progress, then erasing is stopped.

6. If GCA COMM State is On and AREA SEL Value is equal to 1, then the following displays appear on the Cockpit CRT:

   • the GCA Graph at the 0 to 2.5 scale
   • GCA Information

7. If GCA COMM State is On and AREA SEL Value is equal to 2, then the following displays appear on the Cockpit CRT:

   • the GCA Graph at the 0 to 10 scale
   • GCA Information

8. If GCA COMM State is On and AREA SEL Value is equal to 0 or greater than 2, then nothing happens.

9. If FULL SCALE AS State is On, then the Air Speed Graph is enlarged.

10. If FULL SCALE ALT State is On, then the Altitude Graph is enlarged.
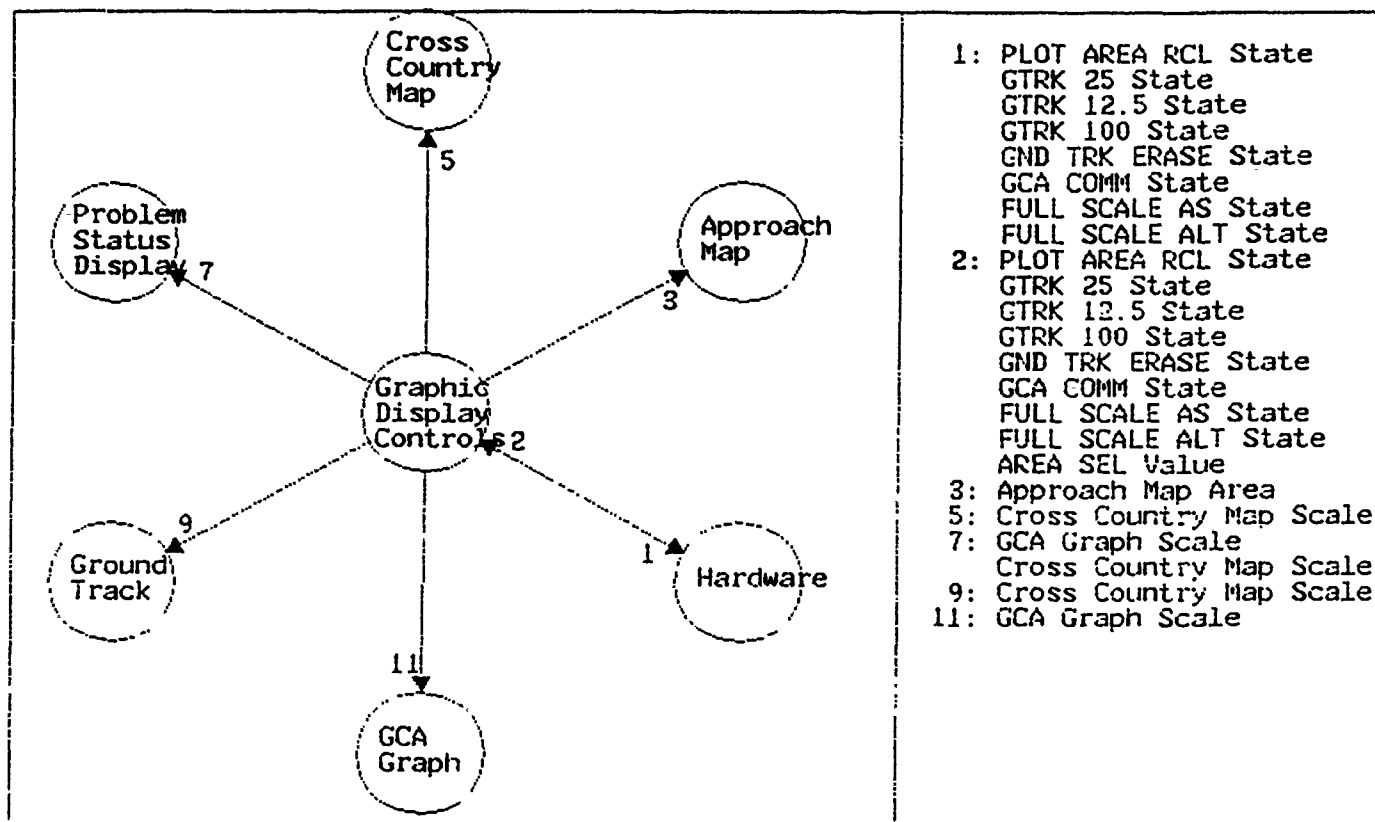
Figure 3-17. Graphic Display Controls CID.

3.1.2.3 Playback Controls

The UH-1 Flight Simulator allows up to five minutes of flight playback to give the instructor and trainee an "instant replay" capability. The Playback Controls control flight simulation playback. The Playback Controls class is depicted in Figure 18.

ATTRIBUTES

1. RESET State
2. PAUSE State
3. IN PROG State
4. SLOW TIME State
5. MIN SEL Value

IMPORTED DATA

<none>

EXPORTED DATA

1. Minutes

PROCESSING

Exported Data

1. Minutes is set according to MIN SEL Value.

Push Buttons

2. If the RESET push button is depressed, the following events occur:

   - The RESET push button is illuminated.
   - Any other illuminated push button on the Playback Control Panel is extinguished.

3. When the reset is completed, the following events occur:

   - The RESET push button is extinguished.
   - The PAUSE push button is illuminated.

4. If the PAUSE push button is depressed while illuminated, the following events occur:

   - The PAUSE push button is extinguished.
   - The IN PROG push button is illuminated.

5. If the PAUSE push button is depressed while extinguished, the following events occur:

   - The IN PROG push button is extinguished.
   - The PAUSE push button is illuminated.

6. When the playback is frozen, the following events occur:

- The IN PROG push button is extinguished.
- The PAUSE push button is illuminated.

7. When depressed, the SLOW TIME push button becomes illuminated if currently extinguished, and extinguished if currently illuminated.

INTERFACES

1. If RESET State is On, then playback is set back the number of minutes indicated by MIN SEL Value.
2. If PAUSE State is On while playback is in progress, then playback is stopped.
3. If PAUSE State is On while playback is in pause, then playback is started.
4. If SLOW TIME State is On while playback is operating at normal speed, then the following events occur:

   - Playback proceeds at 50% normal speed.
   - Audio is disabled.

5. If SLOW TIME State is On while playback is operating at slow speed, then the following events occur:

   - Playback proceeds at normal speed.
   - Audio is enabled.

6. Playback is frozen by the Flight Controls and the Problem Controls.

```
                    ( Hardware )

                         ▲
                         | 1


                       2 |
                         ▼
                   ( Playback  )
                   ( Controls  )


                       3 |
                         ▼
                   ( Playback   )
                   ( Information )
```

1: SLOW TIME State
   RESET State
   PAUSE State
   IN PROG State
2: SLOW TIME State
   RESET State
   PAUSE State
   MIN SEL Value
3: Minutes
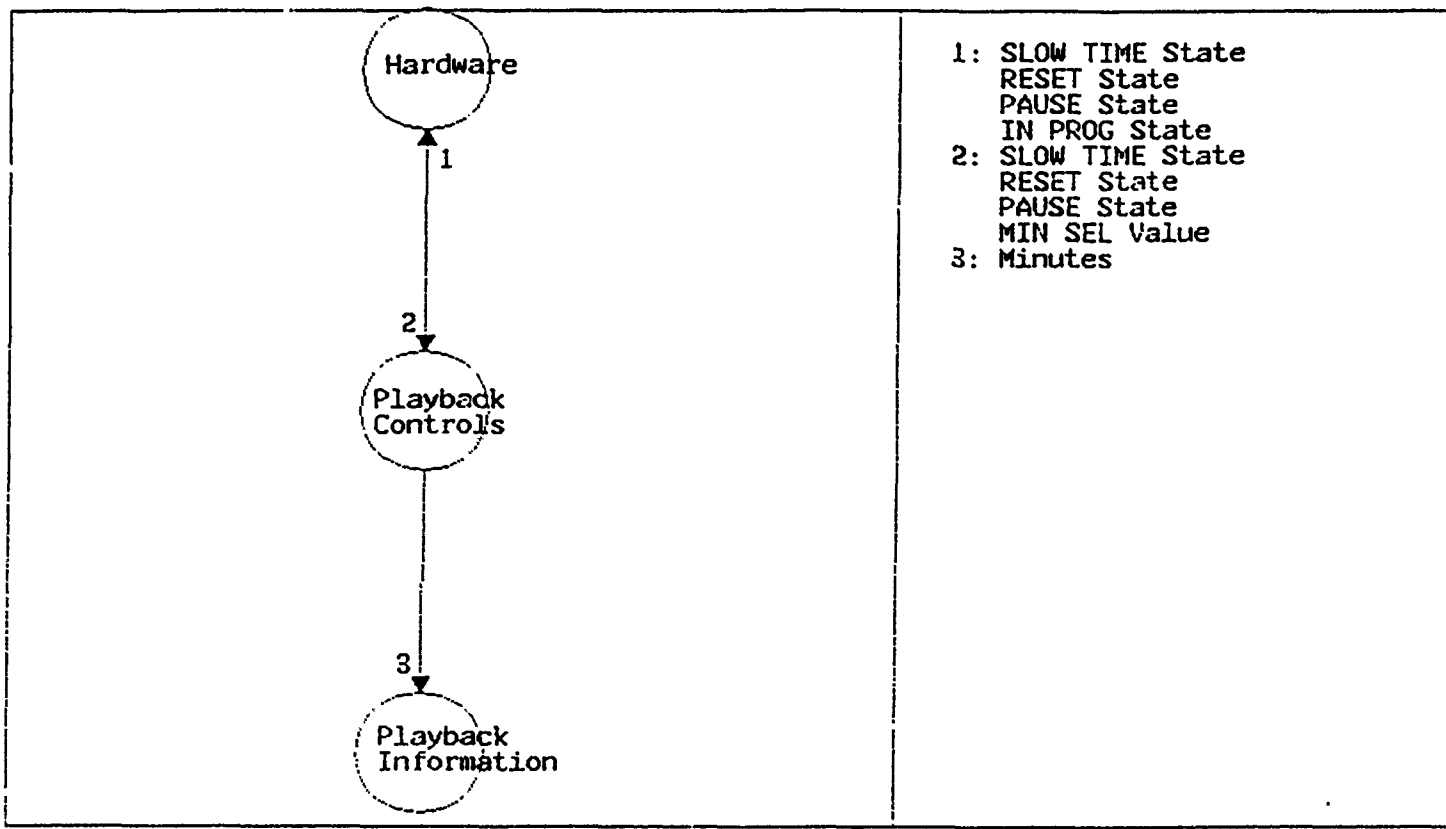
Figure 3-18. Playback Controls CID.

3.1.2.4 Malfunction Controls

The Malfunction Controls provide the capability to enable or disable malfunctions on the Malfunction List. The Malfunction Controls class is depicted in Figure 19.

ATTRIBUTES

1. INSR State
2. INHB RMV State
3. SEL Value

IMPORTED DATA

<none>

EXPORTED DATA

1. Malfunction Identifier

PROCESSING

Exported Data

1. Malfunction Identifier is set according to SEL Value.

Push Buttons

2. The INSR and INHB RMV push buttons are illuminated while depressed, and extinguished when released.

INTERFACES

1. If INSR State is On, then the Malfunction corresponding to SEL Value is enabled.
2. If INHB RMV State is On, then the Malfunction corresponding to SEL Value is disabled.
3. If no Malfunction is assigned to SEL Value, then nothing happens.
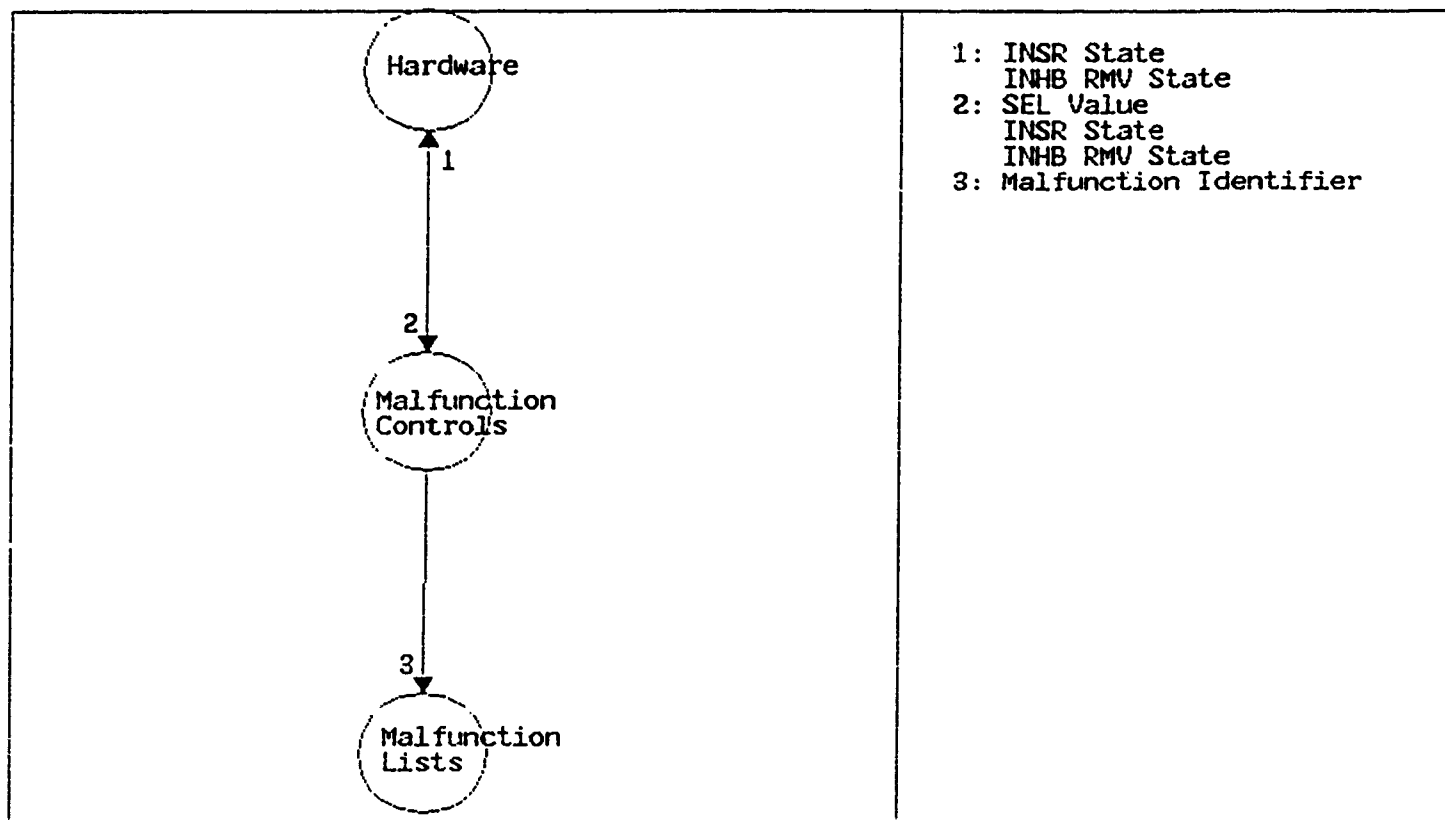
Figure 3-19. Malfunction Controls CID.

3.1.2.5 Flight Controls

The Flight Controls allow the IOS operator to control the simulated flight of the helicopter. The Flight Controls class is depicted in Figure 20.

ATTRIBUTES

1. CRASH OVRD State
2. PROB FRZ State
3. PROB RESET State
4. AUTO COPILOT State
5. ACK STUD State

IMPORTED DATA

1. Instructor Call

EXPORTED DATA

1. Instructor Call

PROCESSING

1. When depressed, the CRASH OVRD push button becomes illuminated .. currently extinguished, and extinguished if currently illuminated.
2. When depressed, the PROB FRZ push button becomes illuminated if currently extinguished, and extinguished if currently illuminated.
3. The PROB RESET push button is illuminated while depressed.
4. When the trainer has completed a reset, the PROB RESET push button is set to flashing.
5. When the PROB RESET push button is released, it is extinguished.
6. If the AUTO COPILOT push button is depressed, it becomes illuminated.
7. The AUTO COPILOT push button is illuminated for as long as the trainer in auto-copilot mode. It is then extinguished.
8. The ACK STUD push button is set to flashing when Instructor Call is Initiated.
9. If the ACK STUD push button is depressed while flashing, the following events occur:

   • The ACK STUD push button is extinguished.
   • Instructor Call is Acknowledged.

INTERFACES

1. If CRASH OVRD State is On while the trainer is in normal operating mode, then the trainer is placed in crash override mode. This means that the trainer will reset the simulation to the problem starting point if the trainee flies the helicopter in a way that causes the flight parameters to go out of tolerance.
2. If CRASH OVRD State is On while the trainer is in crash override mode, then the trainer is placed in normal operating mode. This means that the trainer will place the simulation in freeze if the trainee flies the helicopter in a way that causes the flight parameters to go out of tolerance.
3. If PROB FRZ State is On while the trainer is in normal operating mode, then the trainer is placed in freeze mode.

4. If PROB FRZ State is On while the trainer is in freeze mode, then the trainer is placed in normal operating mode, unless the freeze mode was initiated from the Problem Controls.
5. If PROB RESET State is On, then the Flight Parameters for the trainer are reset to the Initial Condition Set values.
6. If AUTO COPILOT State is On, then the trainer is placed in auto-copilot mode. In this mode the computer maintains straight and level flight.
7. The trainer is set from the auto-copilot to the normal operating mode by the Problem Controls.
8. The ACK STUD push button is illuminated when the INSTR CALL push button on the Problem Controls is depressed.
9. If ACK STUD State is On, then an instructor call from the Problem Controls is acknowledged.
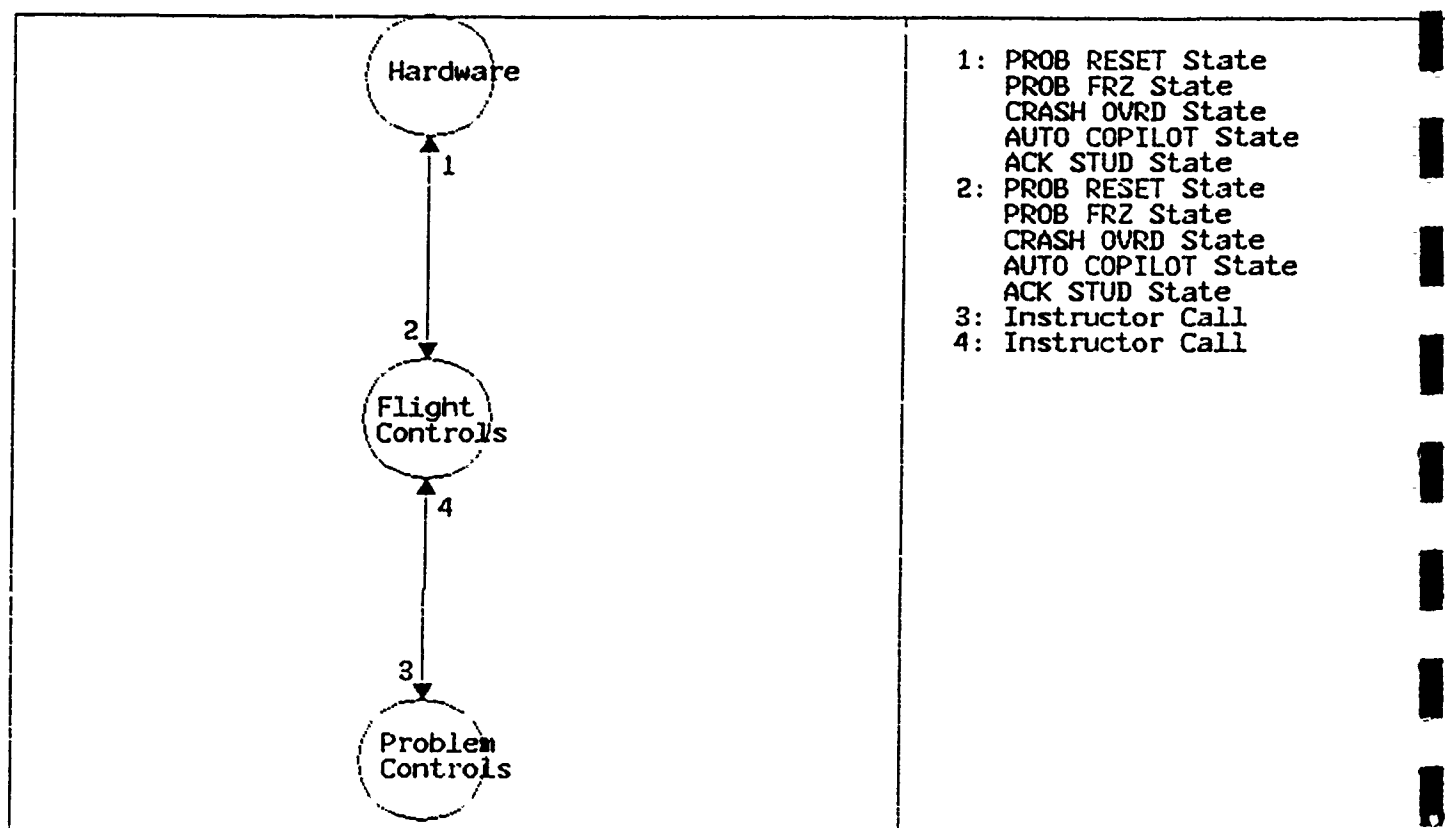
Figure 3-20. Flight Controls CID.

Diagram labels:
- Hardware
- Flight Controls
- Problem Controls

Arrows: 1, 2, 4, 3

Legend:
1: PROB RESET State
   PROB FRZ State
   CRASH OVRD State
   AUTO COPILOT State
   ACK STUD State
2: PROB RESET State
   PROB FRZ State
   CRASH OVRD State
   AUTO COPILOT State
   ACK STUD State
3: Instructor Call
4: Instructor Call

3.1.2.6 Cockpit CRT

The Cockpit CRT is found in two places:

- the IOS
- the Trainee Station.

Each IOS controls two Trainee Stations; therefore, at each IOS there are two Cockpit CRTs. A pictorial representation of the Cockpit CRT is shown in Figure 21. The Cockpit CRT class is depicted in Figure 22.

ATTRIBUTES

1. Problem Status Area State
2. Map Plot Area State
3. Air Speed Graph Area State
4. Altitude Graph Area State

IMPORTED DATA

1. Problem Status Display
2. Air Speed Graph
3. Altitude Graph
4. Cross Country Map
5. Approach Map
6. GCA Graph
7. Ground Track
8. Visual Error Alerts
9. GCA Information

EXPORTED DATA

SEMI
RC1234
J. JONES
     027   LAST

VHFC 127.50 127.50
UHF   234.40
FM   038.40
VHFN 111.20
ADF   212

XPDR NORM

PP   FRZ/CRSH
COP A/S
AND ALT
CCP W
GDP RT
WCS RL
RDV PT
S/T YW
R/T HDG
FUL RR
     TP
WD 315 TRB 8
WV 15

MALF
OPI
FLM OUT
FVL PMP
PNL LTS
ALT FVL CNT
NEW MALF 6
NEW MALF 7
NEW MALF 8
NEW MALF 9
NEW MALF 10

283
013
85
CSG 2200
186 08
GNVA 2200
226 15.5
140
DVS
2000
180 90
CS
055
SLE 200
053 5.7
276
096
AWS 2200
303 9.6

VNE
A/S
120
90
60
30
6000
RT TP   A/S   RR

ALT
6000
5000
4000
3000
2000
1000
0
65   70

GRAPH AREA

Figure 3-21. Cockpit CRT.

PROCESSING

1. Each Cockpit CRT is divided into the following regions:

   - the problem status area
   - the map plot area
   - the graph area.

2. The graph area of the Cockpit CRT is divided into the following subregions:

   - the air speed graph area
   - the altitude graph area.

3. The problem status area runs along the left margin of the Cockpit CRT, 12 inches high by 2 inches wide.
4. The map plot area occupies the top right portion of the Cockpit CRT, 10 inches high by 10 inches wide.
5. The graph area runs along the bottom margin of the Cockpit CRT, 2 inches high by 10 inches wide.

INTERFACES

1. The Problem Status Display appears in the problem status area of the Cockpit CRT.
2. There are three kinds of map that appear in the map plot area of the Cockpit CRT:

   - the Cross Country Map, with Ground Track and Visual Error Alerts
   - the Approach Map
   - the GCA Graph, with GCA Information

3. The Air Speed Graph appears in the air speed graph area of the Cockpit CRT:
4. The Altitude Graph appears in the altitude graph area of the Cockpit CRT:
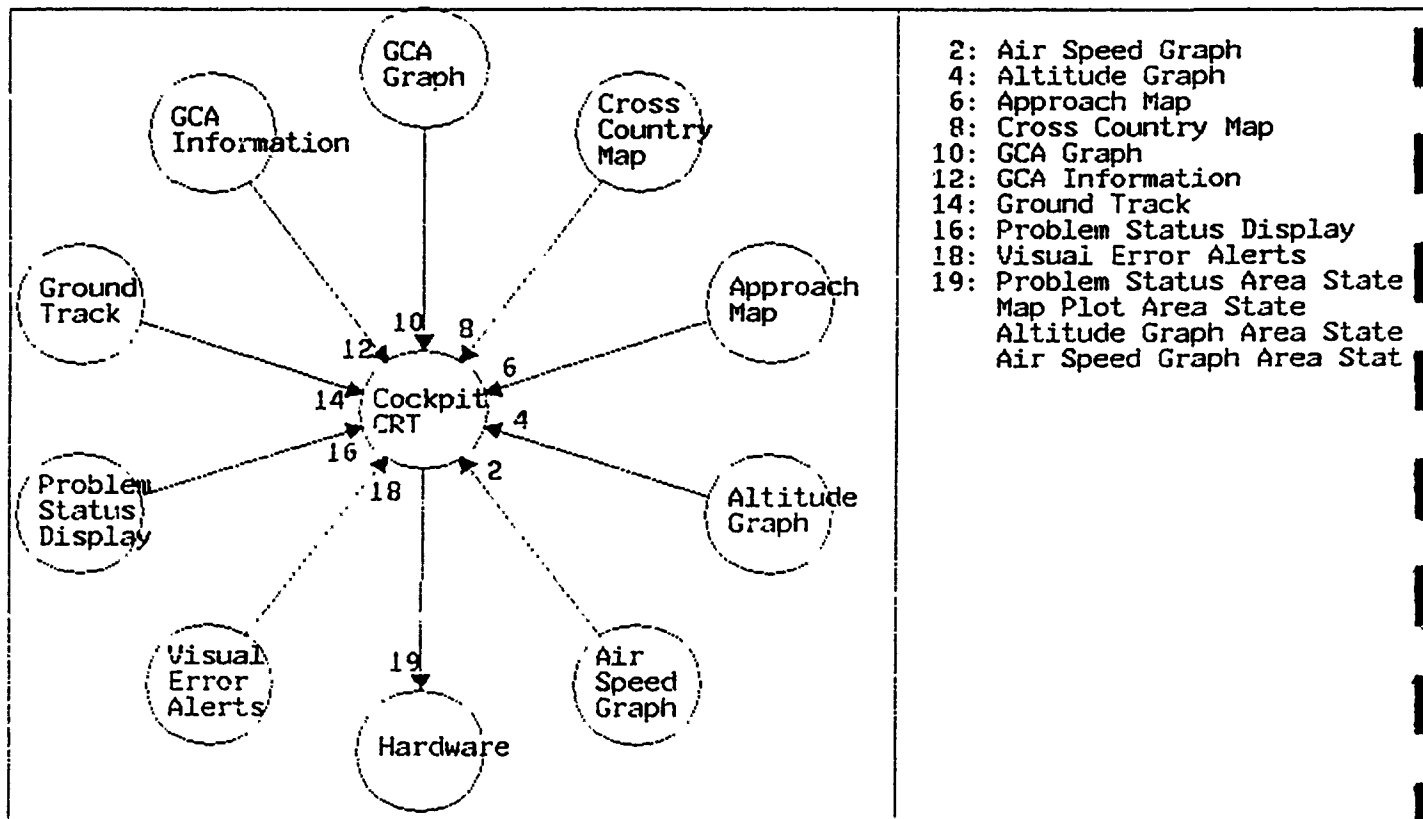
Figure 3-22. Cockpit CRT CID.

The diagram shows "Cockpit CRT" at the center with connections to surrounding circles:

- GCA Graph (10)
- GCA Information (12)
- Cross Country Map (8)
- Ground Track (14)
- Approach Map (6)
- Problem Status Display (16)
- Altitude Graph (4)
- Visual Error Alerts (18)
- Air Speed Graph (2)
- Hardware (19)

Legend:

2: Air Speed Graph
4: Altitude Graph
6: Approach Map
8: Cross Country Map
10: GCA Graph
12: GCA Information
14: Ground Track
16: Problem Status Display
18: Visual Error Alerts
19: Problem Status Area State
    Map Plot Area State
    Altitude Graph Area State
    Air Speed Graph Area Stat

3.1.2.7 Problem Controls

The Problem Controls control the behavior of the cockpit during simulated flight. The Problem Controls class is depicted in Figure 23.

ATTRIBUTES

1. MALF State
2. FRZ State
3. CONT State
4. RESET State
5. AUTO COPILOT State
6. INSTR CALL State
7. IN PROG State
8. SLOW State
9. PROB Value
10. DEMO Value

IMPORTED DATA

1. Instructor Call

EXPORTED DATA

1. Malfunction Identifier
2. Turbulence Level
3. Instructor Call

PROCESSING

Exported Data

1. Malfunction Identifier is set according to PROB Value.
2. Turbulence Level is set according to DEMO Value.

Malfunction Push Buttons

3. The MALF push button is illuminated while it is depressed, and extinguished when released.

Flight Push Buttons

4. The FRZ and CONT push buttons are illuminated when depressed, but only one can be illuminated at a time.
5. The RESET push button is illuminated while depressed.
6. When the trainer has completed a reset, the RESET push button is set to flashing.
7. When the RESET push button is released, it is extinguished.
8. The AUTO COPILOT push button is illuminated when the trainer is set to auto-copilot mode.
9. If the AUTO COPILOT push button is depressed, it becomes extinguished.
10. If the INSTR CALL push button is depressed, the following events occur:

- The INSTR CALL push button is illuminated.
- Instructor Call is Initiated.

11. The INSTR CALL push button is extinguished when Instructor Call is Acknowledged.

Playback Push Buttons

12. The IN PROG push button is illuminated only while the trainer is in playback mode.
13. The SLOW push button is illuminated only while playback is proceeding at slow-time.

INTERFACES

Malfunctions

1. If MALF State is On and PROB Value is greater than 0, then the Malfunction corresponding to that value is enabled if currently disabled.
2. If MALF State is On and PROB Value is greater than 0, then the Malfunction corresponding to that value is disabled if currently enabled.
3. If MALF State is On, PROB Value is equal to 0, and DEMO Value is less than 10, then the Turbulence Level in the Flight Parameters is set to DEMO Value.
4. If no Malfunction is assigned to DEMO Value, then nothing happens.

Flight

5. If FRZ State is On, then the trainer is placed in freeze mode.
6. If CONT State is On, then the trainer is placed in normal operating mode, unless the freeze mode was initiated from the Flight Controls.
7. If RESET State is On, then the Flight Parameters for the trainer are reset to the Initial Condition Set values.
8. If AUTO COPILOT State is On, then the trainer is placed in normal operating mode.
9. The trainer is set from the normal operating to the auto-copilot mode by the Flight Controls.
10. If INSTR CALL State is On, then an instructor call is made to the Flight Controls.
11. The INSTR CALL push button is extinguished when the ACK STUD push button is depressed.

Playback

12. Playback is frozen and unfrozen by the Playback Controls.
13. Playback is slowed and unslowed by the Playback Controls.
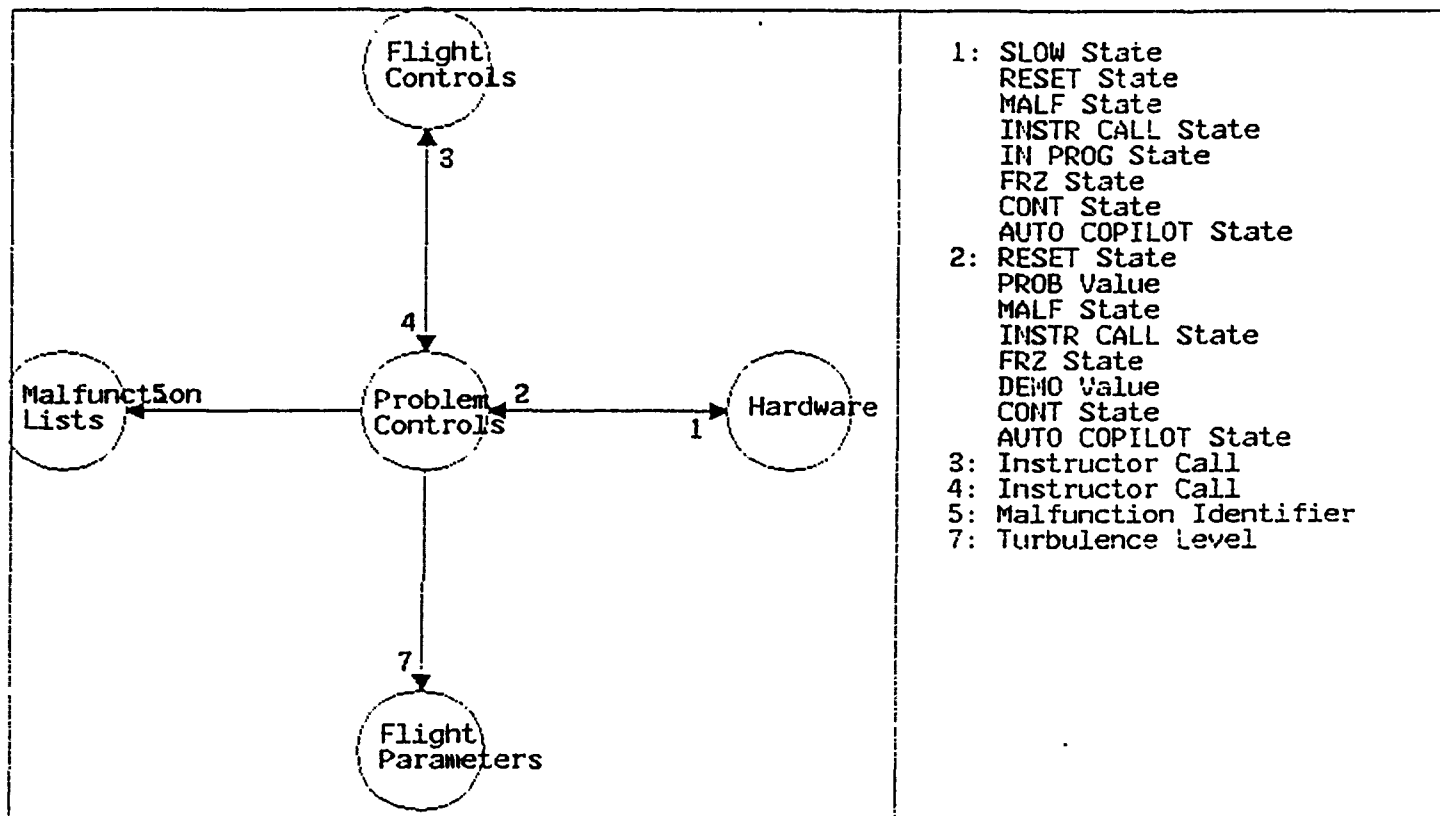
Figure 3-23. Problem Controls CID.

1: SLOW State
   RESET State
   MALF State
   INSTR CALL State
   IN PROG State
   FRZ State
   CONT State
   AUTO COPILOT State
2: RESET State
   PROB Value
   MALF State
   INSTR CALL State
   FRZ State
   DEMO Value
   CONT State
   AUTO COPILOT State
3: Instructor Call
4: Instructor Call
5: Malfunction Identifier
7: Turbulence Level

3.1.2.8 Numeric Keypad

The Numeric Keypad allows values to be entered and a user to move from item to item on a menu. The Numeric Keypad class is depicted in Figure 24.

ATTRIBUTES

1. Control Sequence

IMPORTED DATA

<none>

EXPORTED DATA

1. Cockpit
2. Approach Map Area
3. Initial Condition Set Identifier
4. Flight Parameter Identifier
5. Altitude
6. Air Speed
7. Heading
8. ll
9. P h
10. ʼaw
11. Vertical Velocity
12. Rate of Turn
13. Torque Pressure
14. Rotor RPM
15. Latitude
16. Longitude
17. Fuel Weight
18. Center of Gravity
19. Gross Weight
20. Barometric Pressure
21. Outside Air Temperature
22. Wind Velocity
23. Wind Direction
24. Turbulence Level
25. Sound Level
26. Static Level
27. Auxiliary Power Unit
28. Rate of Fuel Burn
29. Malfunction Identifer
30. Malfunction Status
31. Time of Enablement
32. Facility Identifier
33. Facility Status
34. Duration

PROCESSING

1. Control Sequences are entered using the keys labeled 0 through 9, the decimal key, and the minus key.
2. The CLEAR key sets Control Sequence to null.
3. The ENTER key returns Control Sequence. If it is null, the ENTER key returns a null value.
4. The TAB key returns a null value.

INTERFACES

1. The Numeric Keypad is used to control the display on the Auxiliary Information Display.
2. The Numeric Keypad is used to edit information on the Auxiliary Information Display.

GCA Graph

GCA Information

Cross Country Map

13

Ground Track

15

Approach Map

7

Malfunction Lists

17

Numeric Keypad

Initial Condition Sets

5

19

Visual Error Alerts

2

3

Flight Parameters

21

Stored Plots

23

Navaids

Hardware

2: Control Sequence
3: Yaw
   Wind Velocity
   Wind Direction
   Vertical Velocity
   Turbulence Level
   Torque Pressure
   Static Level
   Sound Level
   Rotor RPM
   Roll
   Rate of Turn
   Rate of Fuel Burn
   Pitch
   Outside Air Temperature
   Longitude
   Latitude
   Heading
   Gross Weight
   Fuel Weight
   Flight Parameter Identifi
   Cockpit
   Center of Gravity
   Barometric Pressure
   Auxiliary Power Unit
   Altitude
   Air Speed
5: Yaw
   Wind Velocity
   Wind Direction

Vertical Velocity
Turbulence Level
Torque Pressure
Static Level
Sound Level
Rotor RPM
Roll
Rate of Turn
Rate of Fuel Burn
Pitch
Outside Air Temperature
Longitude
Latitude
Initial Condition Set Ide
Heading
Gross Weight
Fuel Weight
Cockpit
Center of Gravity
Barometric Pressure
Auxiliary Power Unit
Altitude
Air Speed
 7: Approach Map Area
 9: Cockpit
11: Cockpit
13: Cockpit
15: Cockpit
17: Time of Enablement
    Malfunction Status

Malfunction Identifier
Cockpit
19: Cockpit
21: Duration
    Cockpit
23: Facility Status
    Facility Identifier

Figure 3-24. Numeric Keypad CID.

3.1.2.9 AID Controls

The AID Controls control all editing that takes place on the Auxiliary Information Display. The AID Controls class is depicted in Figure 25.

ATTRIBUTES

Display Select Controls

1. CROSS CNTRY State
2. AREA State
3. GCA State

Display Area Select Controls

4. CKPT 1 AREA State
5. CKPT 2 AREA State
6. CKPT 3 AREA State
7. CKPT 4 AREA State
8. EDIT AREA State

Display/Edit Format Select Controls

9. FAIL State
10. INIT COND State
11. FLT PRMTR State
12. RADIO NAV State
13. STORD PLOTS State

Transfer Cockpit Area to Edit Area Controls

14. 1 State
15. 2 State
16. 3 State
17. 4 State

Flight Parameter Controls

18. FLT PRMTR FRZ State
19. FLT PRMTR RSTRE State

IMPORTED DATA

<none>

EXPORTED DATA

1. Cockpit

PROCESSING

Exported Data

1. If any of the Display Area Select Controls or Transfer Cockpit Area to Edit Area Control push buttons is depressed, Cockpit is set accordingly.

Push Buttons

2. Display Select push buttons are illuminated when depressed, and extinguished when the display disappears from the screen.
3. Display Area Select push buttons are illuminated when depressed, and extinguished when the display appears on the screen.
4. Display/Edit Format Select push buttons are illuminated when depressed, and extinguished when the display disappears from the screen.
5. Transfer Cockpit Area to Edit Area push buttons are illuminated while depressed, and extinguished when released.
6. Flight Parameter Control push buttons are illuminated when depressed, and extinguished when the Flight Parameters are Frozen or Restored.

INTERFACES

Display Select Controls

1. If CROSS CNTRY State is On, then the following displays appear on the Auxiliary Information Display:

   • a Cross Country Map at the default scale
   • a Ground Track
   • any Visual Error Alerts
   • the default map scale in the Problem Status Display

2. If AREA State is On, then the Approach Map entered on the Numeric Keypad is displayed on the Auxiliary Information Display.
3. If GCA State is On, then the following displays appear on the Auxiliary Information Display:

   • the GCA Graph at the scale entered on the Numeric Ke,,ad
   • GCA Information

CKPT AREA Push Buttons and Display/Edit Format Select Controls

4. If CKPT 1 AREA, CKPT 2 AREA, CKPT 3 AREA, or CKPT 4 AREA State is On along with FAIL State, then the Malfunction List for the selected cockpit is displayed in the cockpit display area of the Auxiliary Information Display.
5. If CKPT 1 AREA, CKPT 2 AREA, CKPT 3 AREA, or CKPT 4 AREA State is On along with INIT COND State, then the Initial Condition Set for the selected cockpit is displayed in the cockpit display area of the Auxiliary Information Display.
6. If CKPT 1 AREA, CKPT 2 AREA, CKPT 3 AREA, or CKPT 4 AREA State is On along with FLT PRMTR State, then the Flight Parameters for the selected cockpit are displayed in the cockpit display area of the Auxiliary Information Display.
7. Malfunction Lists, Initial Condition Sets, and Flight Parameters from more than one cockpit may be displayed at one time.

EDIT AREA Push Buttons and Display/Edit Format Select Controls

8. If EDIT AREA State is On along with FAIL State, then the Malfunction List menus are displayed in the edit area of the Auxiliary Information Display. This allows the Malfunction Lists to be edited.

9. If EDIT AREA State is On along with INIT COND State, then the Initial Condition Set menus are displayed in the edit area of the Auxiliary Information Display. This allows the Initial Condition Sets to be edited.

10. If EDIT AREA State is On along with FLT PRMTR State, then the Flight Parameter menus are displayed in the edit area of the Auxiliary Information Display. This allows the Flight Parameters to be edited.

11. If EDIT AREA State is On along with RADIO NAV State, then the Navaid menus are displayed in the edit area of the Auxiliary Information Display. This allows the Navaids to be edited.

12. If EDIT AREA State is On along with STORD PLOTS State, then the Stored Plot menus are displayed in the edit area of the Auxiliary Information Display.

Transfer Cockpit Area to Edit Area Controls

13. If 1, 2, 3, or 4 State is On, then the display for that cockpit is toggled between the cockpit display area and the edit area of the Auxiliary Information Display. This allows the user to shift a display back and forth between display-only and edit mode.

14. Only one display can be in the edit area at one time; hence, before a second display can be shifted to the edit area, the first display must be shifted back to the cockpit display area.

Flight Parameter Controls

15. If FLT PRMTR FRZ State is On, then the Flight Parameter entered on the Numeric Keypad is frozen to its current value.

16. If FLT PRMTR RSTRE State is On, then the Flight Parameter entered on the Numeric Keypad is unfrozen.
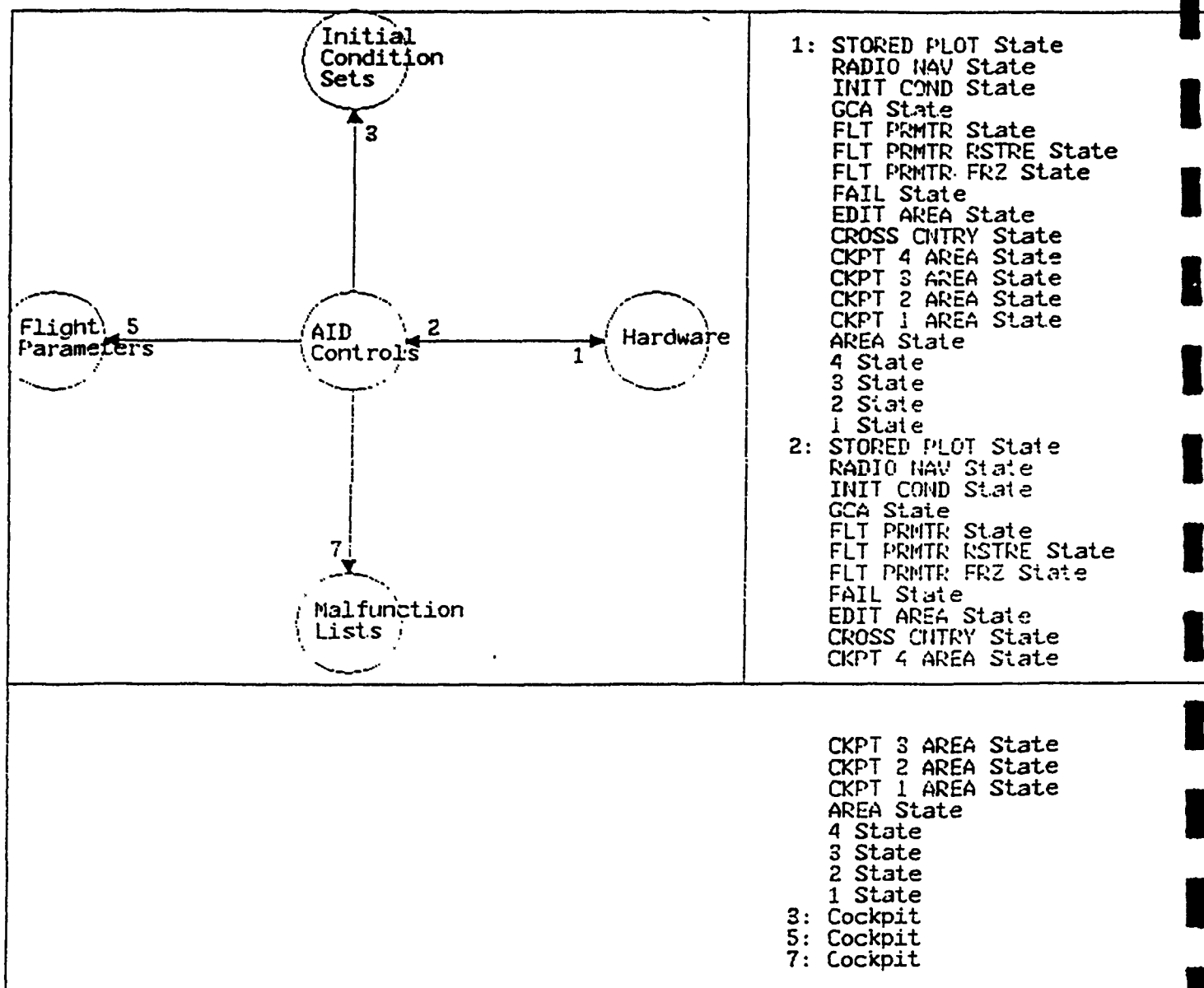
Figure 3-25. AID Controls CID.

1: STORED PLOT State
   RADIO NAV State
   INIT COND State
   GCA State
   FLT PRMTR State
   FLT PRMTR RSTRE State
   FLT PRMTR FRZ State
   FAIL State
   EDIT AREA State
   CROSS CNTRY State
   CKPT 4 AREA State
   CKPT 3 AREA State
   CKPT 2 AREA State
   CKPT 1 AREA State
   AREA State
   4 State
   3 State
   2 State
   1 State
2: STORED PLOT State
   RADIO NAV State
   INIT COND State
   GCA State
   FLT PRMTR State
   FLT PRMTR RSTRE State
   FLT PRMTR FRZ State
   FAIL State
   EDIT AREA State
   CROSS CNTRY State
   CKPT 4 AREA State

   CKPT 3 AREA State
   CKPT 2 AREA State
   CKPT 1 AREA State
   AREA State
   4 State
   3 State
   2 State
   1 State
3: Cockpit
5: Cockpit
7: Cockpit

3.1.2.10 Auxiliary Information Display

The Auxiliary Information Display (AID) is a CRT whose displays are controlled by the AID Controls and the Numeric Keypad. A pictorial representation of the AID is shown in Figure 26. The Auxiliary Information Display class is depicted in Figure 27.

ATTRIBUTES

1. Cockpit #1 Display Area State
2. Cockpit #2 Display Area State
3. Cockpit #3 Display Area State
4. Cockpit #4 Display Area State
5. Cockpit #1 Edit Area State
6. Cockpit #2 Edit Area State
7. Cockpit #3 Edit Area State
8. Cockpit #4 Edit Area State

IMPORTED DATA

1. Cross Country Map
2. Approach Map
3. GCA Graph
4. Ground Track
5. Visual Error Alerts
6. GCA Information
7. Initial Condition Set
8. Flight Parameter List
9. Malfunction List
10. Navaid List
11. Stored Plot List

EXPORTED DATA

<none>

DISPLAY AREA SEL

EDIT AREA	CKPT 1 AREA	CKPT 2 AREA	CKPT 3 AREA	CKPT 4 AREA
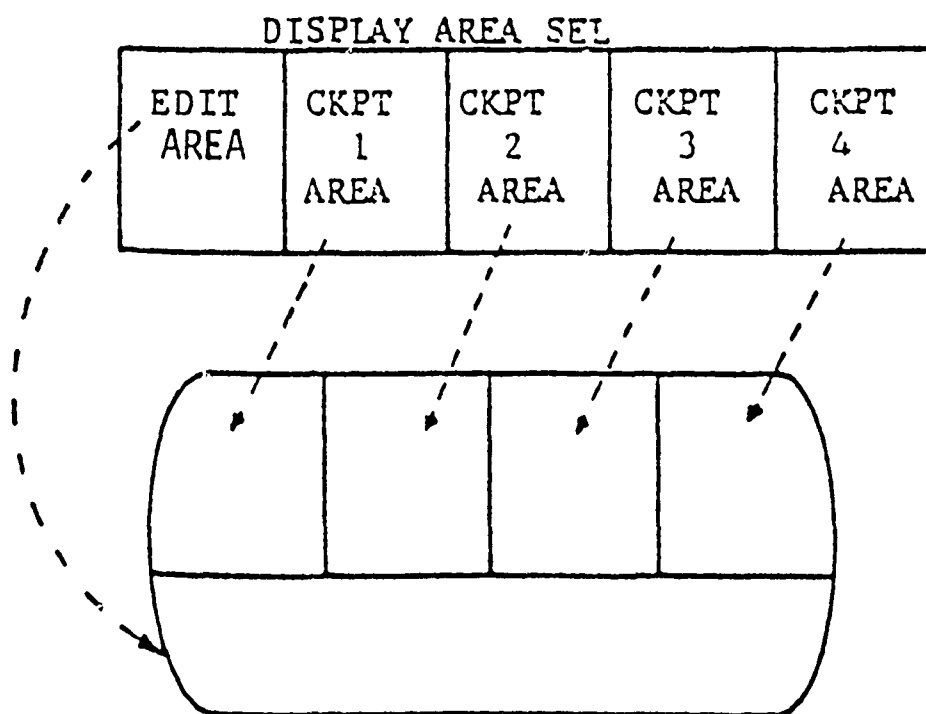
Figure 3-26. Auxiliary Information Display.

PROCESSING

1. Each Auxiliary Information Display is divided vertically into the following regions:

   - the cockpit display area
   - the edit area.

2. Each Auxiliary Information Display is divided horizontally into the following regions:

   - the Cockpit #1 area
   - the Cockpit #2 area
   - the Cockpit #3 area
   - the Cockpit #4 area.

3. The cockpit display area runs along the top margin of the Auxiliary Information Display, 6 inches high by 12 inches wide.
4. The edit area runs along the bottom margin of the Auxiliary Information Display, 6 inches high by 12 inches wide.
5. Each individual cockpit area is 12 inches high by 3 inches wide.
6. The cockpit display area is a read-only area.
7. The edit area is a read-write area.

INTERFACES

1. There are three kinds of map that can appear on the AID:

   - the Cross Country Map, with Ground Track and Visual Error Alerts
   - the Approach Map
   - the GCA Graph, with GCA Information

2. Initial Condition Sets, Flight Parameter Lists, and Malfunction Lists may be either displayed in the cockpit area of the AID or edited in the edit area.
3. Navaid Lists and Stored Plot Lists are edited in the edit area of the AID.
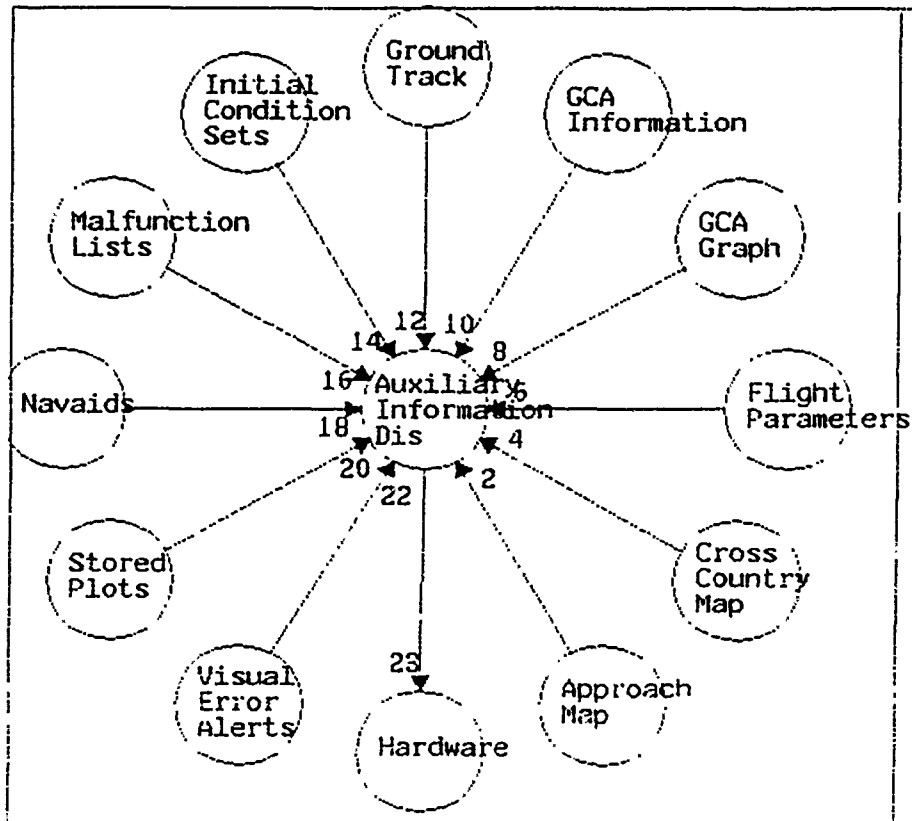
Figure 3-27. Auxiliary Information Display CID.

Communication Control Panel

3.1.2.11 Communication Controls

The Communication Controls allow communication between the IOS and the Trainee Stations and between the Trainee Stations themselves to be turned on and off. The Communication Controls class is depicted in Figure 28.

ATTRIBUTES

    1.   UHF State
    2.   VHF State
    3.   VHF NAV State
    4.   ICS State
    5.   COMM AUDIO NET State
    6.   MON STUD HDST State
    7.   ATC State

IMPORTED DATA

    <none>

EXPORTED DATA

    1.   Channel

PROCESSING

    Exported Data

    1.   If the UHF, VHF, FM, VHF NAV, or ICS push button is depressed, Channel is set accordingly.

    Push Buttons

    2.   The UHF, VHF, FM, VHF NAV, and ICS push buttons are illuminated when depressed, but only one can be illuminated at a time.
    3.   When depressed, the COMM AUDIO NET, MON STUD HDST, and ATC push buttons become illuminated if currently extinguished, and extinguished if currently illuminated.

INTERFACES

    1.   If UHF, VHF, FM, VHF NAV, or ICS State is On, then the corresponding communication channel is opened.
    2.   If the COMM AUDIO NET push button is depressed while common audio is off, then common audio is enabled if the following conditions are met:

       • The simulated helicopters are within line-of-sight of each other.
       • The simulated helicopters are tuned to the same radio frequency.

    This means that the simulated helicopters will all be able to communicate with each other.
    3.   If COMM AUDIO NET State is On while common audio is on, then common audio is disabled.
    4.   If MON STUD HDST State is On while communication monitoring is off, then communication

monitoring is enabled. This means that all communications between the simulated helicpters can be monitored by the instructor operator.

5. If MON STUD HDST State is On while communication monitoring is on, then communication monitoring is disabled.

6. If ATC State is On while chatter is off, then chatter is enabled. This means that radio noise will be simulated for the corresponding trainer.

7. If ATC State is On while chatter is on, then chatter is disabled.

Hardware

1

2

Communication
Controls

3

Trainee
Station
CSC

1: VHF NAV State
   VHF FM State
   UHF State
   MON STUD HDST State
   ICS State
   COMM AUDIO NET State
   ATC State
2: VHF NAV State
   VHF FM State
   UHF State
   MON STUD HDST State
   ICS State
   COMM AUDIO NET State
   ATC State
3: Channel
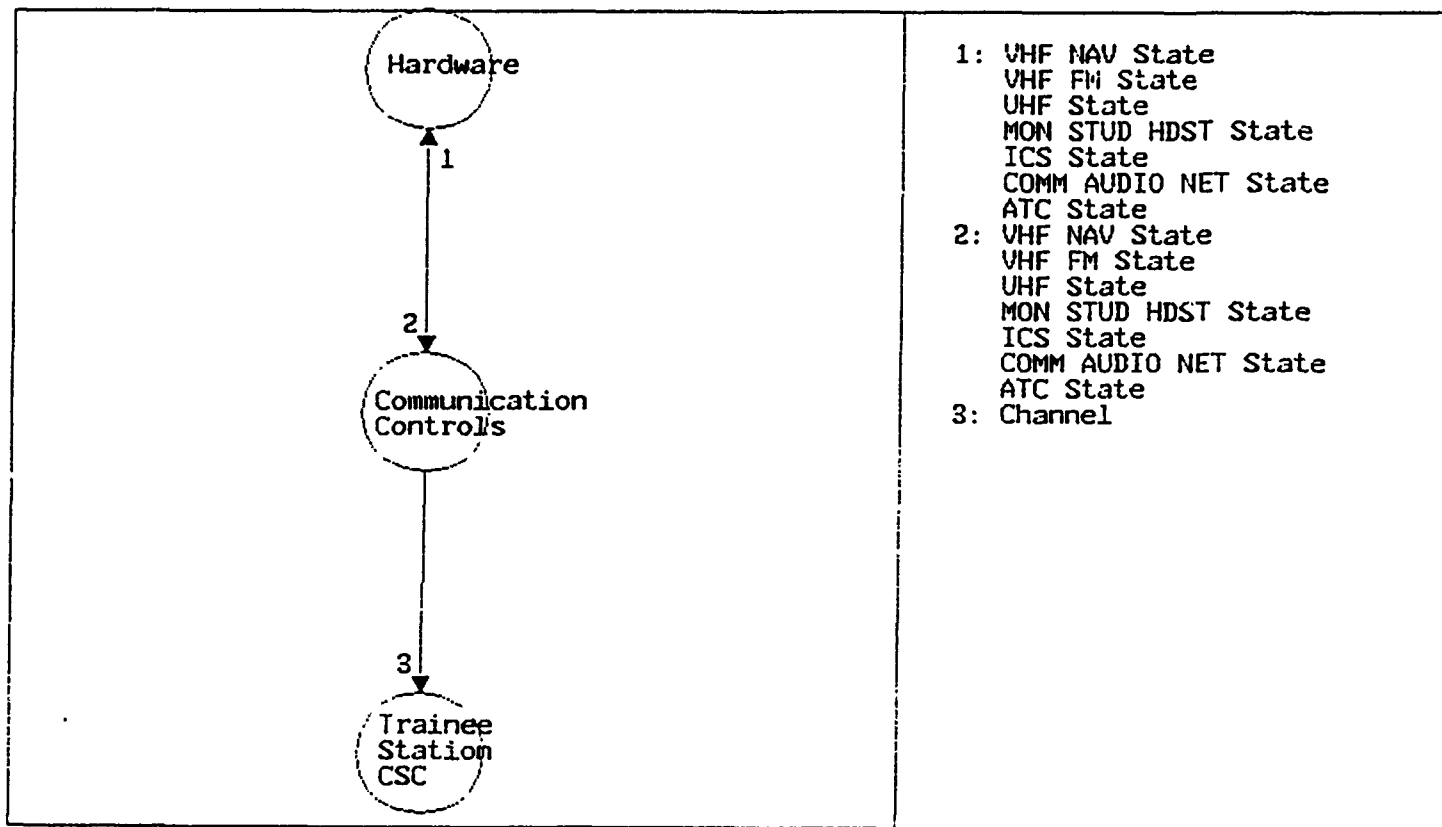
Figure 3-28. Communication Controls CID.

3.1.2.12 Cockpit Display Select Controls

The Cockpit Display Select Controls control the cockpit information displayed on the Cockpit CRT and the Cockpit Indicator Display. The Cockpit Display Select Controls class is depicted in Figure 29.

ATTRIBUTES

1. 1 State
2. 2 State
3. 3 State
4. 4 State

IMPORTED DATA

<none>

EXPORTED DATA

1. Cockpit

PROCESSING

Exported Data

1. If the 1, 2, 3, or 4 push button is depressed, Cockpit is set accordingly.

Push Buttons

2. The push button that was depressed is illuminated, but only one can be illuminated at a time.

INTERFACES

1. The Cockpit value controls the following displays on the Cockpit CRT:

    • the Problem Status Display
    • the Air Speed and Altitude Graphs
    • the Cross Country Map, with Ground Track and Visual Error Alerts
    • the GCA Graph, with GCA Information

2. If 1, 2, 3, or 4 State is On, then the readings of the instruments for that cockpit are displayed on the Cockpit Indicator Display.
3. Only one set of readings can be displayed at one time.
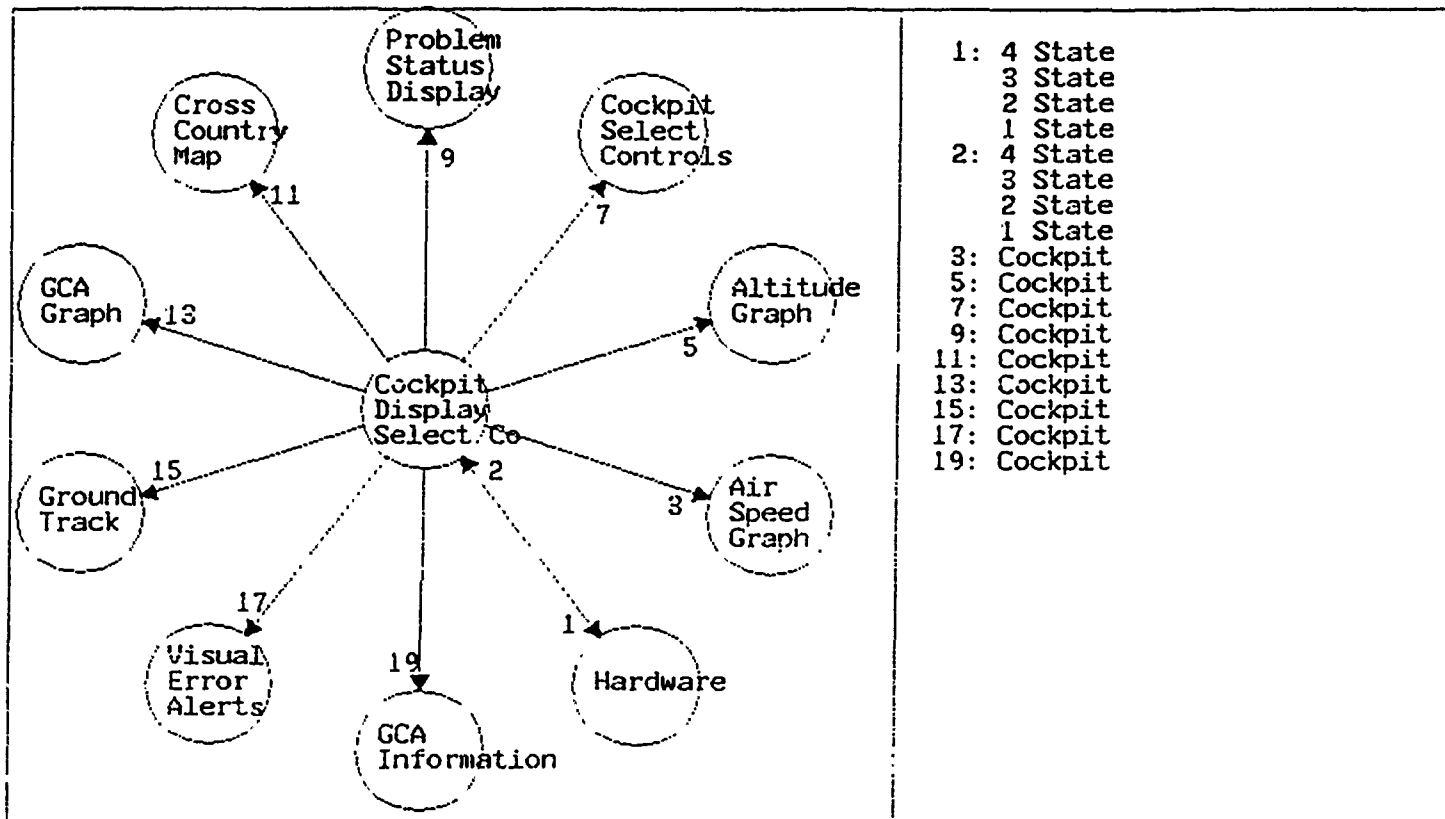
Figure 3-29. Cockpit Display Select Controls CID.

3.1.2.13 Cockpit Select Controls

The Cockpit Select Controls show which cockpit's instruments are currently being displayed on the Cockpit Indicator Display. The Cockpit Select Controls class is depicted in Figure 30.

ATTRIBUTES

1. 1 State
2. 2 State
3. 3 State
4. 4 State

IMPORTED DATA

1. Cockpit

EXPORTED DATA

<none>

PROCESSING

1. The push button coresponding to Cockpit is illuminated.
2. Any other illuminated push button is extinguished.

INTERFACES

1. The Cockpit Select Controls register the cockpit number whose instrument readings are currently being displayed on the Cockpit Indicator Display.
2. Cockpit is set by the Cockpit Display Select Controls.

Cockpit
Display
Select Co

2: Cockpit
3: 4 State
    3 State
    2 State
    1 State

2

Cockpit
Select
Controls

3

Hardware
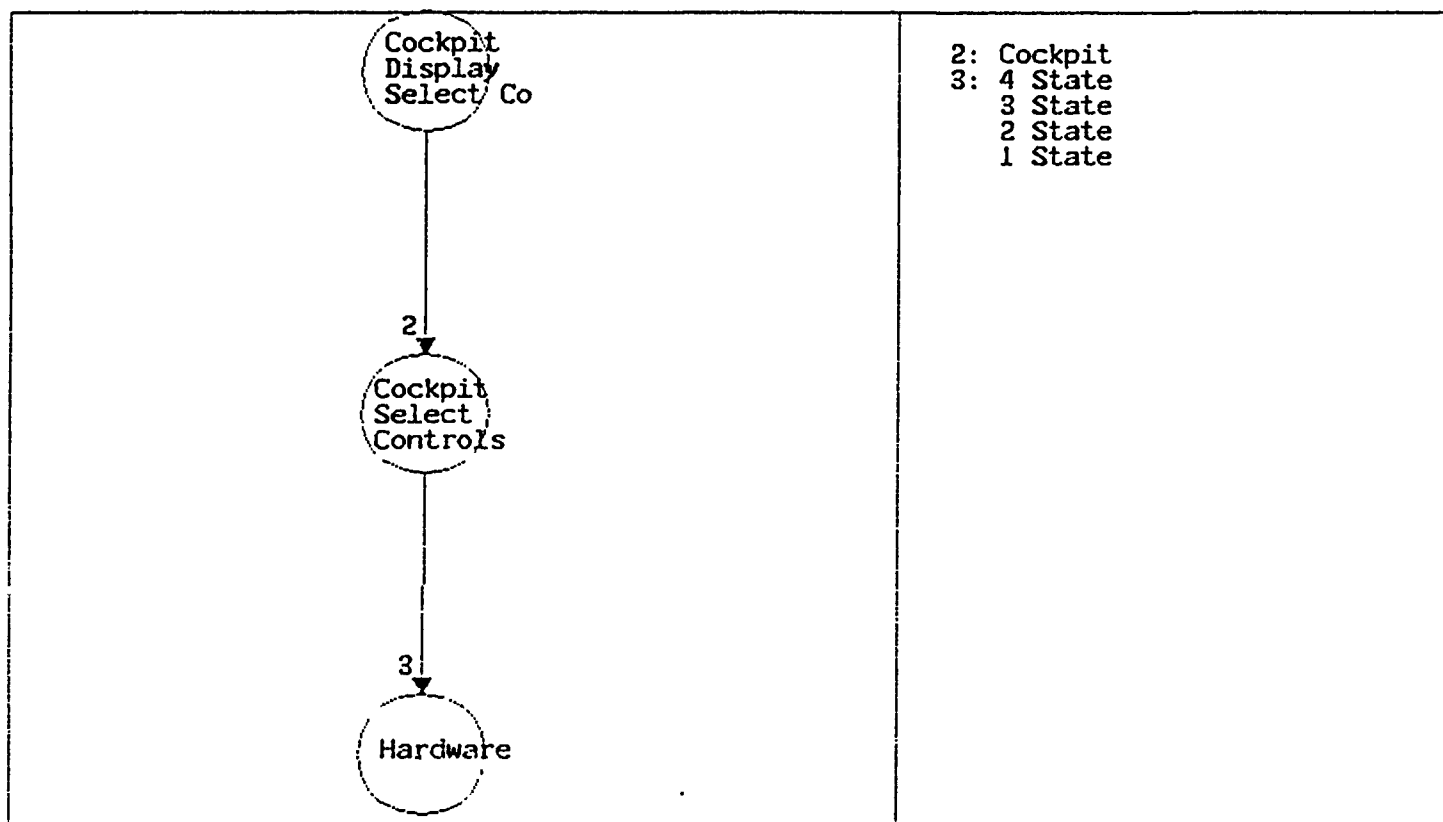
Figure 3-30. Cockpit Select Controls CID.

3-59

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3.2 CSCI CAPABILITY REQUIREMENTS

This section includes all subsystems in the UH-1 Helicopter Flight Simulator system.

SUBSYSTEM

1. Flight Monitor
2. Editable Displays
3. Flight History

3.2.1 FLIGHT MONITOR

This subsystem includes all classes that monitor the simulated flight of the UH-1.

CLASSES

Auxiliary Displays

1. Problem Status Display
2. Air Speed Graph
3. Altitude Graph

Maps

4. Cross Country Map
5. Approach Map
6. GCA Graph

Map Components

7. Ground Track
8. Visual Error Alerts
9. GCA Information

Auxiliary Displays

3.2.1.1 <u>Problem Status Display</u>

The Problem Status Display is a continuous display of trainer status information. It appears in the problem status area on the Cockpit CRT. The problem status area is an area along the left margin of the Cockpit CRT, 2 x 12 inches. For a pictorial representation of the Problem Status Display, see Figures 18, 19, 20, 21, or 22. The Problem Status Display class is depicted in Figure 31.

ATTRIBUTES

1. Mode of Operation
2. Radio Call Number
3. Exercise in Progress
4. Elapsed Time
5. VHFC Frequency
6. UHF Frequency
7. FM Frequency
8. VHFN Frequency
9. ADF Frequency
10. Transponder Mode
11. Last Frequency on Which Aircraft Transmitted
12. Partial Panel
13. Auto Copilot
14. Ground Communication in Progress
15. Weight on Skids
16. Trainer Ready
17. Assistance Requested
18. Slow Time
19. Real Time
20. Twenty Minute Fuel Remaining Indication
21. Freeze/Crash
22. Map Scale
23. Altitude Frozen
24. Air Speed Frozen
25. Heading Frozen
26. Roll Frozen
27. Pitch Frozen
28. Yaw Frozen
29. Vertical Velocity Frozen
30. Rate of Turn Frozen
31. Torque Pressure Frozen
32. Rotor RPM Frozen
33. Wind Direction
34. Wind Velocity
35. Turbulence Level
36. Malfunction List

IMPORTED DATA

1. Cockpit
2. Mode of Operation

3. Radio Call Number
4. Exercise in Progress
5. VHFC Frequency
6. UHF Frequency
7. FM Frequency
8. VHFN Frequency
9. ADF Frequency
10. Transponder Mode
11. Partial Panel
12. Auto Copilot
13. Ground Communication in Progress
14. Weight on Skids
15. Trainer Ready
16. Assistance Requested
17. Slow Time
18. Real Time
19. Twenty Minute Fuel Remaining Indication
20. Freeze/Crash
21. Cross Country Map Scale
22. GCA Graph Scale
23. Altitude Frozen
24. Air Speed Frozen
25. Heading Frozen
26. Roll Frozen
27. Pitch Frozen
28. Yaw Frozen
29. Vertical Velocity Frozen
30. Rate of Turn Frozen
31. Torque Pressure Frozen
32. Rotor RPM Frozen
33. Wind Direction
34. Wind Velocity
35. Turbulence Level
36. Malfunction List

EXPORTED DATA

1. Problem Status Display

PROCESSING

1. The information on the Problem Status Display is divided into the following groups:

   - Training Mode Group
   - Air Traffic Control Group
   - Instructor Alerts Group
   - Environmental Conditions Group
   - Malfunction Status Group.

2. The Training Mode Group is composed of the following information:

   - SEMI, indicating the semiautomatic training mode

- Aircraft call number
- First initial and first five letters of the last name of student
- Elaped problem time in minutes.

3. The Air Traffic Control Group is composed of the following headings and information:

Heading	Information
VHFC	VHFC radio frequency
UHF	UHF radio frequency
FM	FM radio frequency
VHFN	VHFN radio frequency
ADF	ADF radio frequency
XPDR	Transponder mode
LAST	Last radio frequequency the student transmitted on.

4. The Instructor Alerts Group is composed of the following information:

- Instructor alerts
- Map Scale
- Flight parameters which can be frozen.

5. Possible instructor alerts and their abbreviations are as follows:

Symbol	Alert
PP	Partial panel
COP	Auto copilot
GCP	Ground call in progress
WOS	Weight on skids
RDY	Trainer ready
AID	Instructor call
S/T	Slow time
R/T	Real time
FUL	20-Minut fuel remaining
FRZ/CRSH	Freeze/Crash.

6. Freezable flight parameter abbreviations are as follows:

Flight Parameter	Abbreviation
Altitude	ALT
Air Speed	A/S
Heading	HDG
Roll	RL
Pitch	PT
Yaw	YW
Vertical Velocity	VV
Rate of Turn	RT
Torque Pressure	TP
Rotor RPM	RR

7. The Environmental Conditions Group is composed of the following headings and information:

Heading	Information
WD	Wind direction
WV	Wind velocity
TRB	Air turbulence level

8. The Malfunction Group is composed of the following headings and information:

Heading	Information
MALF	Up to 10 malfunctions (both timed and untimed) that have been activated.

9. The following items will be set to high intensity in the following situations:

Item	Situation
Instuctor alert	When in effect
Malfunction	When enabled

10. The following items will blink in the following situations:

Item	Situation
Radio frequency	When opened (i.e. when the trainee depresses the push-to-talk button)
FRZ/CRSH	When a crash has occured
Timed malfunctions	15 seconds before it is enabled.

11. At all other times an item will be displayed in normal intensity.

INTERFACES

1. The Cockpit for the Problem Status Display is entered on the Cockpit Display Select Controls.
2. The Problem Status Display displays data from the Trainee Station CSC, the Flight Parameters, and the Malfunction Lists.
3. The Problem Status Display appears in the problem status area of the Cockpit CRT or the AID.
4. The Problem Status Display is displayed on the Cockpit CRT at system startup, when the SEMI AUTO push button on the Mode Controls is depressed.
5. The default map scale appears on the Problem Status Display on the Cockpit CRT when either of the following occurs:

   • the PLOT AREA RCL push button on the Graphic Display Controls is depressed and the AREA SEL thumbwheel switch is set to 0.
   • the SEMI AUTO push button on the Mode Controls is depressed to start the system.

6. The appropriate map scale appears on the Problem Status Display on the Cockpit CRT when the GTRK 12.5 X 12.5, GTRK 25 X 25, or GTRK 100 X 100 push button on the Graphic Display Controls is depressed.

```
2: Weight on Skids
   VHFN Frequency
   VHFC Frequency
   UHF Frequency
   Twenty Minute Fuel Remain
   Transponder Mode
   Trainer Ready
   Slow Time
   Real Time
   Radio Call Number
   Partial Panel
   Ground Communication in P
   Freeze/Crash
   FM Frequency
   Exercise in Progress
   Auto Copilot
   Assistance Requested
   ADF Frequency
4: Yaw Frozen
   Wind Velocity
   Wind Direction
   Vertical Velocity Frozen
   Turbulence Level
   Torque Pressure Frozen
   Rotor RPM Frozen
   Roll Frozen
   Rate of Turn Frozen
   Pitch Frozen
   Heading Frozen
   Altitude Frozen

    Air Speed Frozen
 6: Cockpit
 8: GCA Graph Scale
    Cross Country Map Scale
10: Malfunction List
12: Mode of Operation
13: Problem Status Display
```

Figure 3-31. Problem Status Display CID.

3.2.1.2 Air Speed Graph

The Air Speed Graph is a plot of air speed against time. It appears in the rectangular area beneath the map plot area on the Cockpit CRT at one of two scales:

- It can appear in the graph area only. At this scale the graph plots air speed in 30 knot increments from 0 to 120 knots versus seconds.

- It can appear enlarged in both the graph area and the map plot area, overwriting the current display in the map plot area. At this scale the graph plots air speed in 15 knot increments from 0 to 120 knots versus seconds.

For a pictorial representation of these areas of the Cockpit CRT, see Figures. 32, 34, 36, 38, or 40. An example of a full-scale Air Speed Graph appears in Figure 32. The Air Speed Graph class is depicted in Figure 33.

ATTRIBUTES

1. Air Speed

IMPORTED DATA

1. Cockpit
2. Air Speed

EXPORTED DATA

1. Air Speed Graph

PROCESSING

1. The vertical axis shows air speed in 30 knot increments from 0 to 120 knots.
2. Numerals appear every 30 knots on the vertical axis.
3. The horizontal axis shows time in 5 minute increments.
4. Numerals appear every 5 minutes on the horizontal axis.
5. The track is plotted in 1 minute increments.
6. The plot accomodates the last 15 minutes of time.
7. If the image reaches the left column of the Air Speed Graph area, the graph is shifted one minute to the right and a plot of the most recent minute of Air Speed is displayed in the left column.
8. If the Air Speed Graph is displayed in full scale, the small-scale graph still appears.
9. The full-scale Air Speed Graph uses the same horizontal and vertical scaling increments as the small-scale Air Speed Graph.

INTERFACES

1. The Cockpit for the Air Speed Graph is entered on the Cockpit Display Select Controls.
2. The Air Speed Graph receives the current Air Speed from the Trainee Station CSC.
3. The Air Speed Graph appears in the upper half of the Graph Area of the Cockpit CRT.
4. The Air Speed Graph is displayed at normal size at system startup, when the SEMI AUTO push button on the Mode Controls is depressed.

5. The Air Speed Graph is displayed at full scale when the FULL SCALE AS push button on the Graphic Display Controls is depressed.

SEMI

RC1234

J. JONES

027   LAST

VHFC   127.50   127.50

UHF   234.40

FM   038.40

VHFN   111.20

ADF   212

XPDR   NORM

PP   FRZ/CRSH

COP   A/S

AID   ALT

GCP   W

GDP   RT

WOS   RL

RDV   PT

S/T   YW

R/T   HDG

FUL   RR

       TP

WD 3:5   TRB 8

WV 15

MALF

OPI

FLM OUT

FVL PMP

PNL LTS

AUT FUL CNT

NEW MALF 6

NEW MALF 7

NEW MALF 8

NEW MALF 9

NEW MALF 10
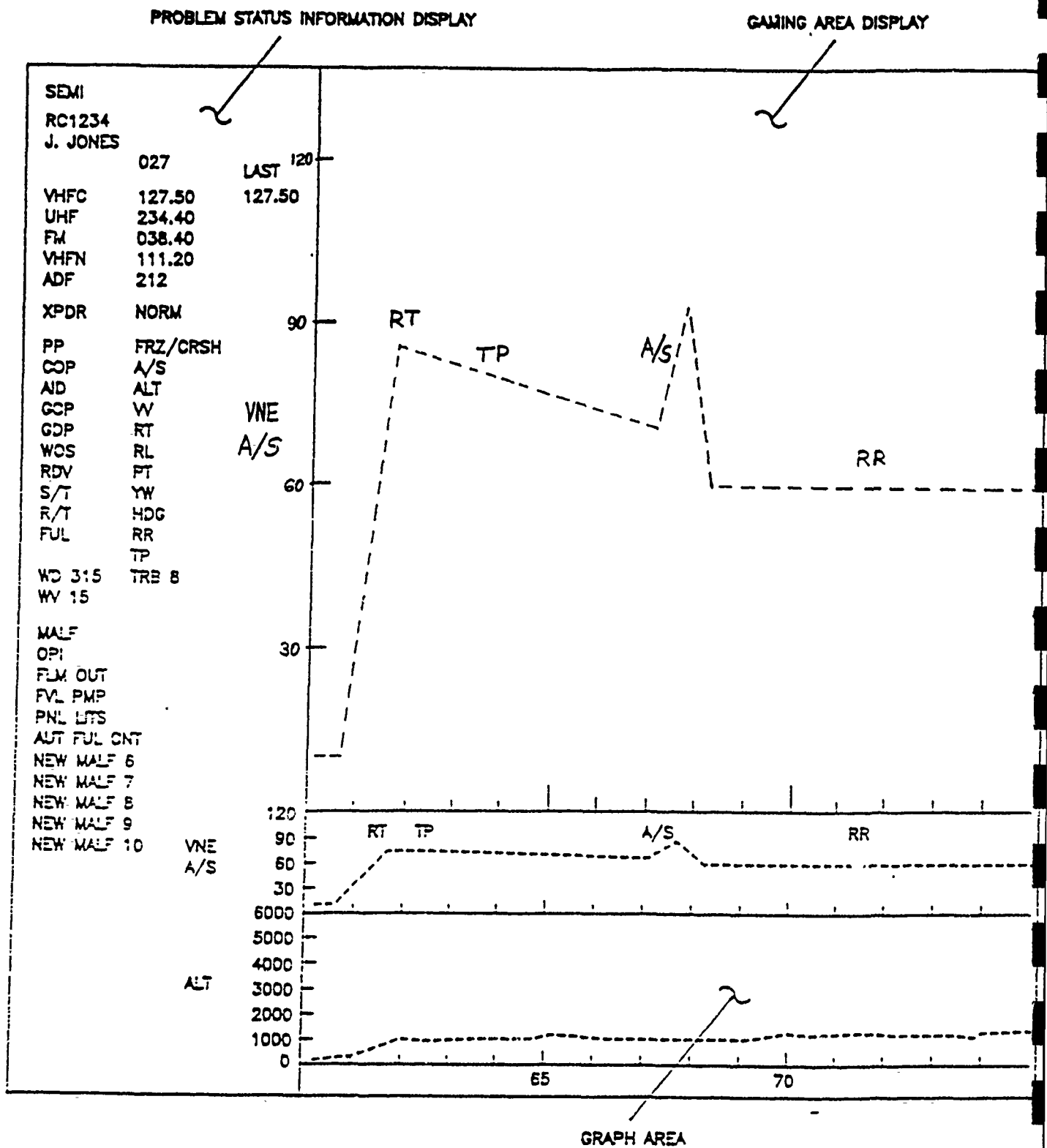
Figure 3-32. Full-Scale Air Speed Graph.
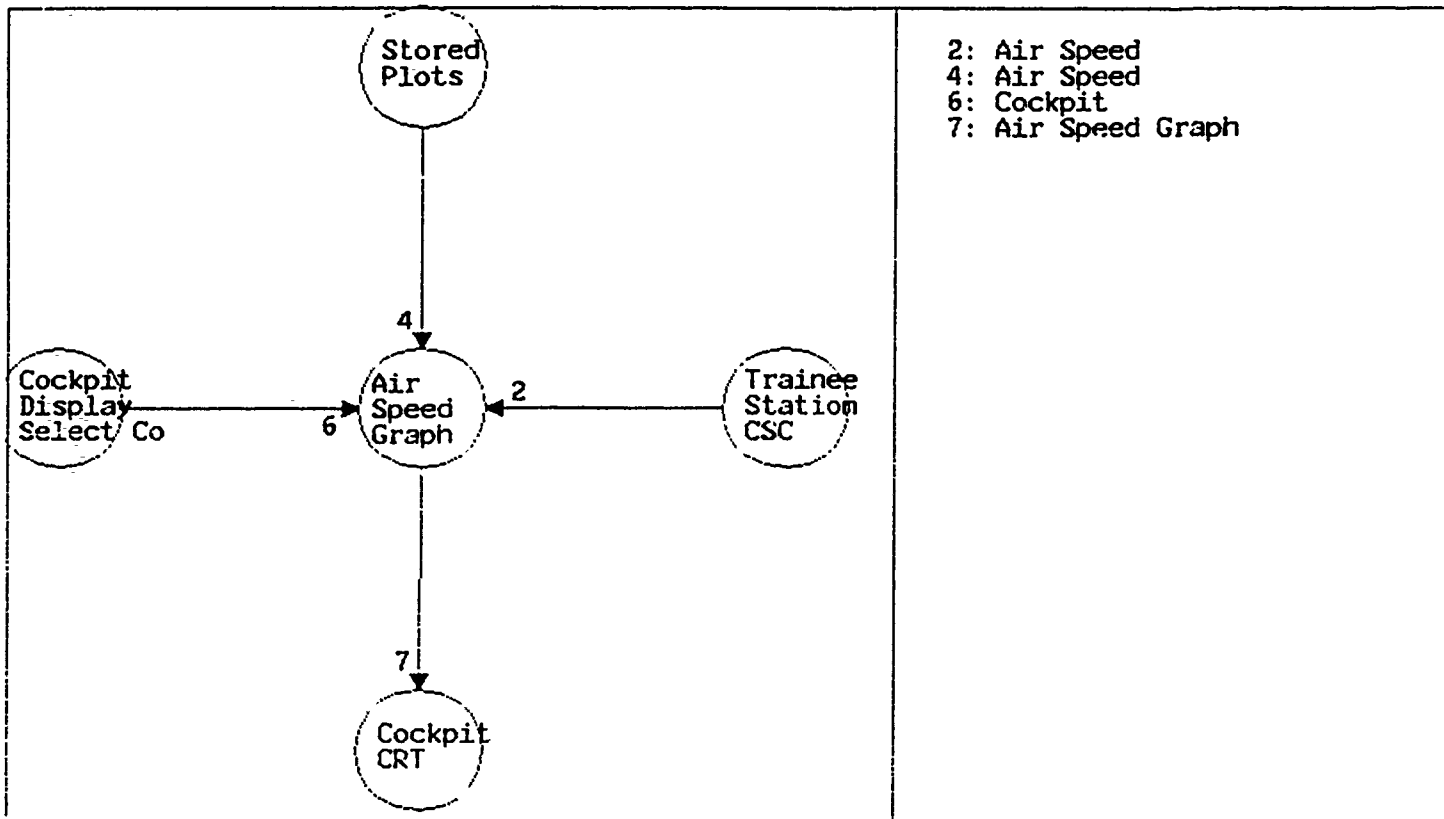
Figure 3-33. Air Speed Graph CID.

3.2.1.3 Altitude Graph

The Altitude Graph is a plot of altitude against time. It appears in the rectangular area beneath the map plot area on the Cockpit CRT at one of two scales:

- It can appear in the graph area only. At this scale the graph plots altitude in 10ú. f~ ʲ increments from 0 to 6000 feet versus seconds.

- It can appear enlarged in both the graph area and the map plot area, overwriting the current display in the map plot area. At this scale the graph plots altitude in 500 foot increments from 0 to 6000 feet versus seconds.

For a pictorial representation of these areas of the Cockpit CRT, see Figures 32, 34, 36, 38, or 40. An example of a full-scale Altitude Graph appears in Figure 34. The Altitude Graph class is depicted in Figure 35.

ATTRIBUTES

    1. Altitude

IMPORTED DATA

    1. Cockpit
    2. Altitude

EXPORTED DATA

    1. Altitude Graph

PROCESSING

    1. The vertical axis shows altitude in 1000 foot increments from 0 to 6000 feet.
    2. Numerals appear every 1000 feet on the vertical axis.
    3. The horizontal axis shows time in increments of 5 minutes.
    4. Numerals appear every 5 minutes on the horizontal axis.
    5. The track is plotted in 1 minute increments.
    6. The plot accomodates the last 15 minutes of time.
    7. If the image reaches the left column of the Altitude Graph area, the graph is shifted one minute to the right and a plot of the most recent minute of Altitude is displayed in the left column.
    8. If the Altitude Graph is displayed in full scale, the small-scale graph still appears.
    9. The full-scale Altitude Graph uses the same horizontal scaling increments as the small-scale Altitude Graph.
    10. The vertical scaling increments of the full-scale Altitude Graph are displayed up the left side, in increments of 500 feet, from 0 to 6000 feet.
    11. Numerals appear every 500 feet on the vertical axis of the full-scale Altitude Graph.

INTERFACES

    1. The Cockpit for the Altitude Graph is entered on the Cockpit Display Select Controls.
    2. The Altitude Graph receives the current Altitude from the Trainee Station CSC.

3. The Altitude Graph appears in the lower half of the Graph Area of the Cockpit CRT.
4. The Altitude Graph is displayed at normal size at system startup, when the SEMI AUTO push button on the Mode Controls is depressed.
5. The Altitude Graph is displayed at full scale when the FULL SCALE ALT push button on the Graphic Display Controls is depressed.

SEMI

RC1234

J. JONES

	027	LAST
VHFC	127.50	127.50
UHF	234.40	
FM	038.40	
VHFN	111.20	
ADF	212	

XPDR   NORM

PP   FRZ/CRSH
COP   A/S
AID   ALT
GCP   W
GDP   RT
WCS   RL
RDV   PT
S/T   YW
R/T   HDG
FUL   RR
        TP

WD 315   TRB 8
WV 15

MALF
OP!
FLM OUT
FVL PMP
PNL LTS
AUT FUL CNT
NEW MALF 6
NEW MALF 7
NEW MALF 8
NEW MALF 9
NEW MALF 10

5000
4000
ALT
3000
2000
1000

VNE
A/S
120
90
60
30

RT TP   A/S   RR

6000
5000
4000
ALT
3000
2000
1000
0

65   70

GRAPH AREA
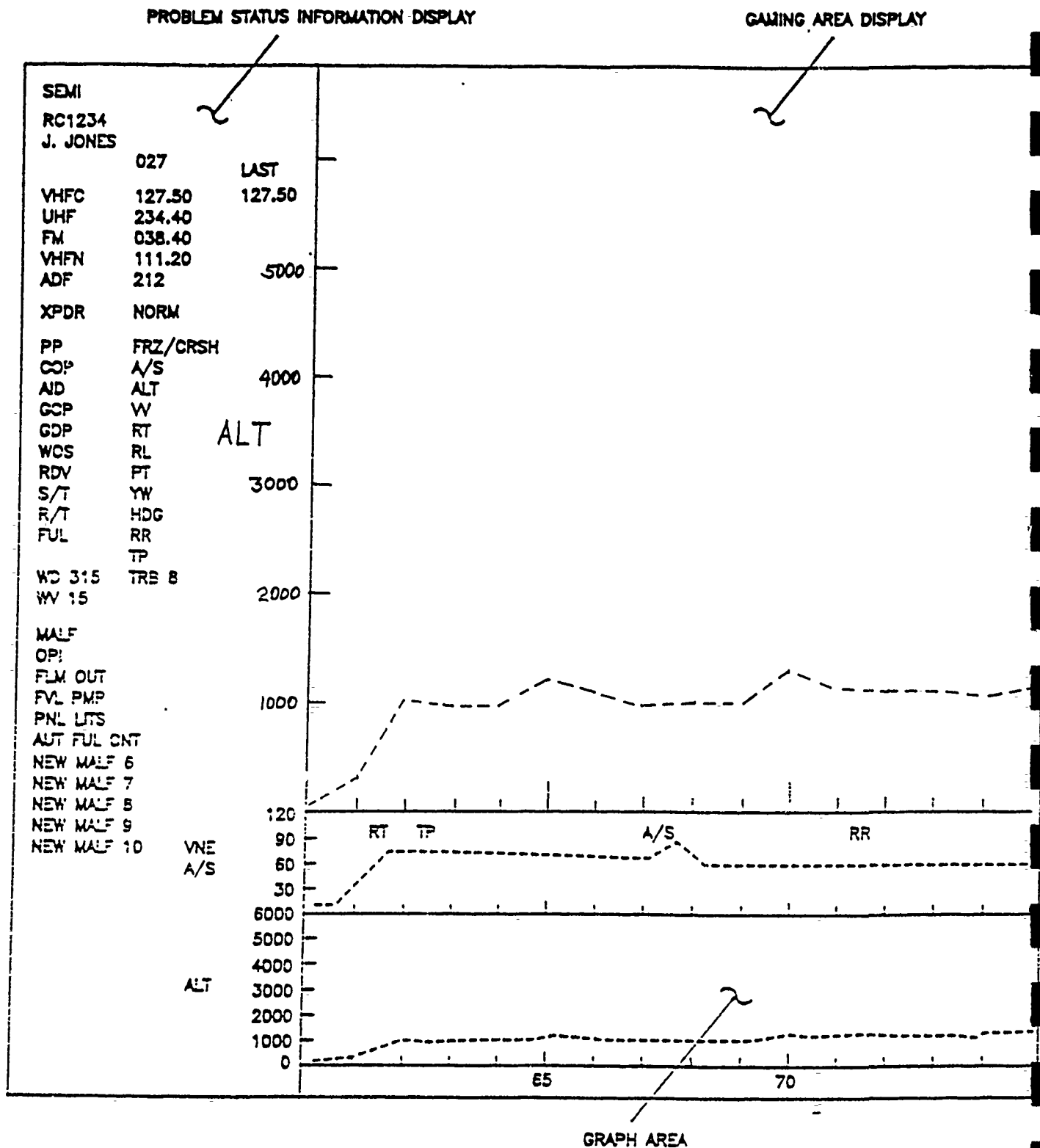
Figure 3-34. Full-Scale Altitude Graph.

3-73
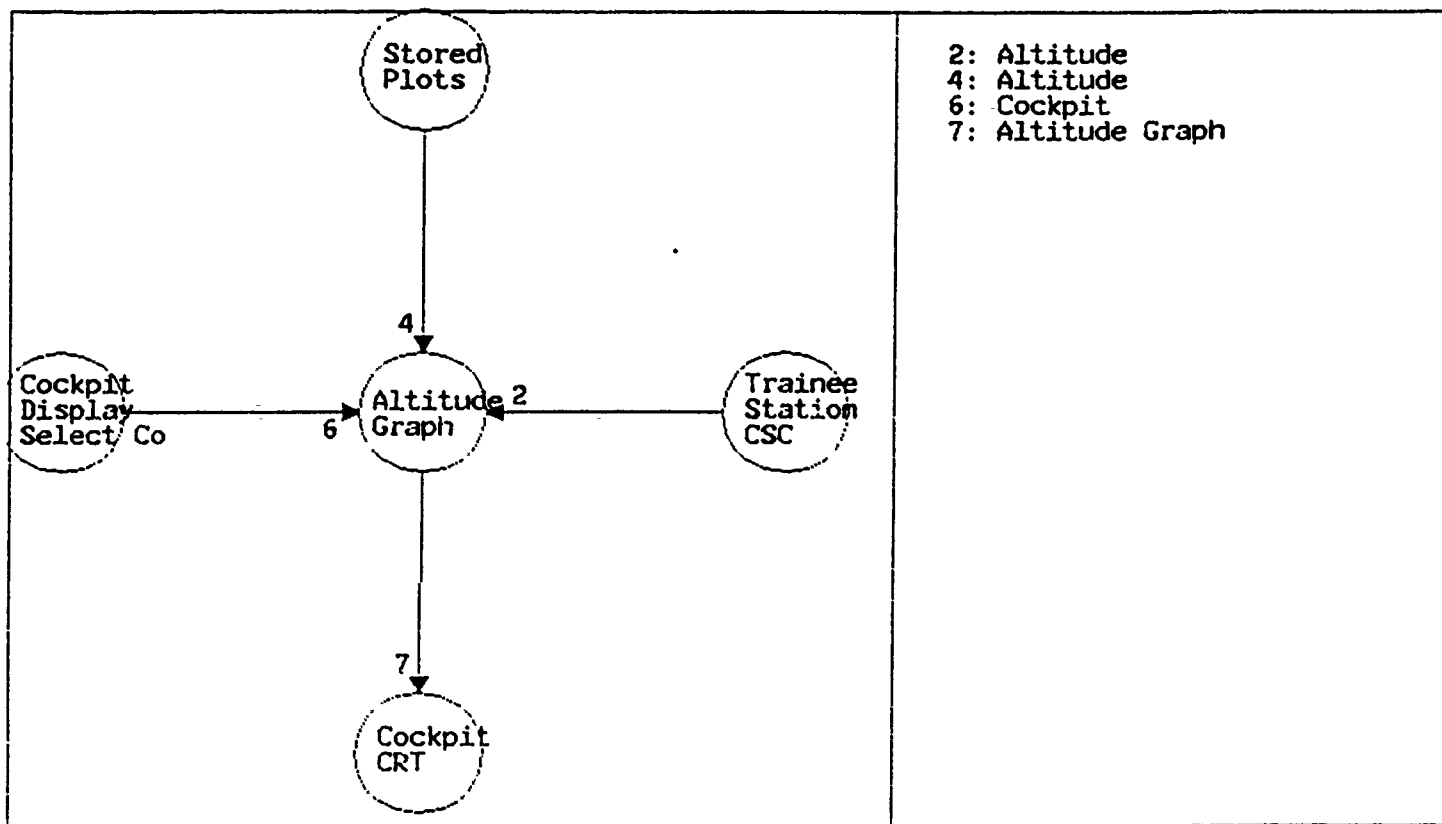
Figure 3-35. Altitude Graph CID.

3.2.1.4 Cross Country Map

The Cross Country Map is a map of the navaids located in the entire gaming area. It appears on the Cockpit CRT at one of three scales:

- 12.5 x 12.5 nautical miles,

- 25 x 25 nautical miles,

- 100 x 100 nautical miles,

It also appears on the AID, the scale being 100 x 100. An example of a Cross Country Map appears in Figure 36. The Cross Country Map class is depicted in Figure 37.

ATTRIBUTES

    1. Cross Country Map Scale
    2. Navigational Facilities
    3. Latitude
    4. Longitude

IMPORTED DATA

    1. Cockpit
    2. Cross Country Map Scale
    3. Navigational Facilities
    4. Latitude
    5. Longitude

EXPORTED DATA

    1. Cross Country Map

PROCESSING

    1. The display is initialized with the current Latitude and Longitude in the center.
    2. The Cross Country Map appears at one of the following scales:

        • 12.5 x 12.5 nautical miles,
        • 25 x 25 nautical miles,
        • 100 x 100 nautical miles,

    3. The default scale for a Cross Country Map is 100 x 100.

INTERFACES

    1. The Cross Country Map consists of the following components

        • the Navigational Facilities within the vicinity of the helicopter
        • a Ground Track of the helicopter's flight path

- any Visual Error Alerts

2. The Navigational Facilities shown in the Cross Country Map are read from a data base.
3. The Cross Country Map is initialized with the current Latitude and Longitude from the Trainee Station CSC.
4. Visual Error Alerts represent out-of-tolerance flight conditions in the helicopter.
5. Visual Error Alerts appear above and to the left of the Ground Track and at the top of the Air Speed Graph located above the time at which they occurred.
6. The Cockpit for the Cross Country Map appearing on the Cockpit CRT is entered on the Cockpit Display Select Controls.
7. The Cockpit for the Cross Country Map appearing on the AID is entered on the Numeric Keypad.
8. The Cross Country Map appears in the map plot area of the Cockpit CRT at any scale.
9. The Cross Country Map appears on the AID at the default scale.
10. A Cross Country Map at the default scale is displayed on the Cockpit CRT at system startup, when the SEMI AUTO push button on the Mode Controls is depressed.
11. A Cross Country Map at the default scale is displayed on the Cockpit CRT when the PLOT AREA RCL push button on the Graphic Display Controls is depressed and the AREA SEL thumbwheel switch is set to 0.
12. A Cross Country Map at the appropriate scale is displayed on the Cockpit CRT when the GTRK 12.5 X 12.5, GTRK 25 X 25, or GTRK 100 X 100 push button on the Graphic Display Controls is depressed.
13. A Cross Country Map at the default scale is displayed on the AID when the CROSS CNTRY push button on the AID Controls is depressed.

PROBLEM STATUS INFORMATION DISPLAY

GAMING AREA DISPLAY

SEMI

RC1234

J. JONES

|27   LAST

		27	127.50
VHFC	127.50	
UHF	234.40	
FM	038.40	
VHFN	111.20	
ADF	212	

XPDR   NORM

PP	FRZ/CRSH
COP	A/S
AID	ALT
GCP	W
GDP	RT
WCS	RL
RDV	PT
S/T	YW
R/T	HDG
FUL	RR
	TP

WD 315   TRB 8

WV 15

MALF

OPI

FLM OUT

FVL PMP

PNL LTS

AUT FUL CNT

NEW MALF 6

NEW MALF 7

NEW MALF 8

NEW MALF 9

NEW MALF 10

WETUM

MG

MILER

MGM

SHADY

PETRY

RUTEL

A/S   TP   RT

SKIPO

VNE   120   90   RT   TP   A/S   RR
A/S   60
       30
       6000

ALT   5000
       4000
       3000
       2000
       1000
       0

65   70

GRAPH AREA
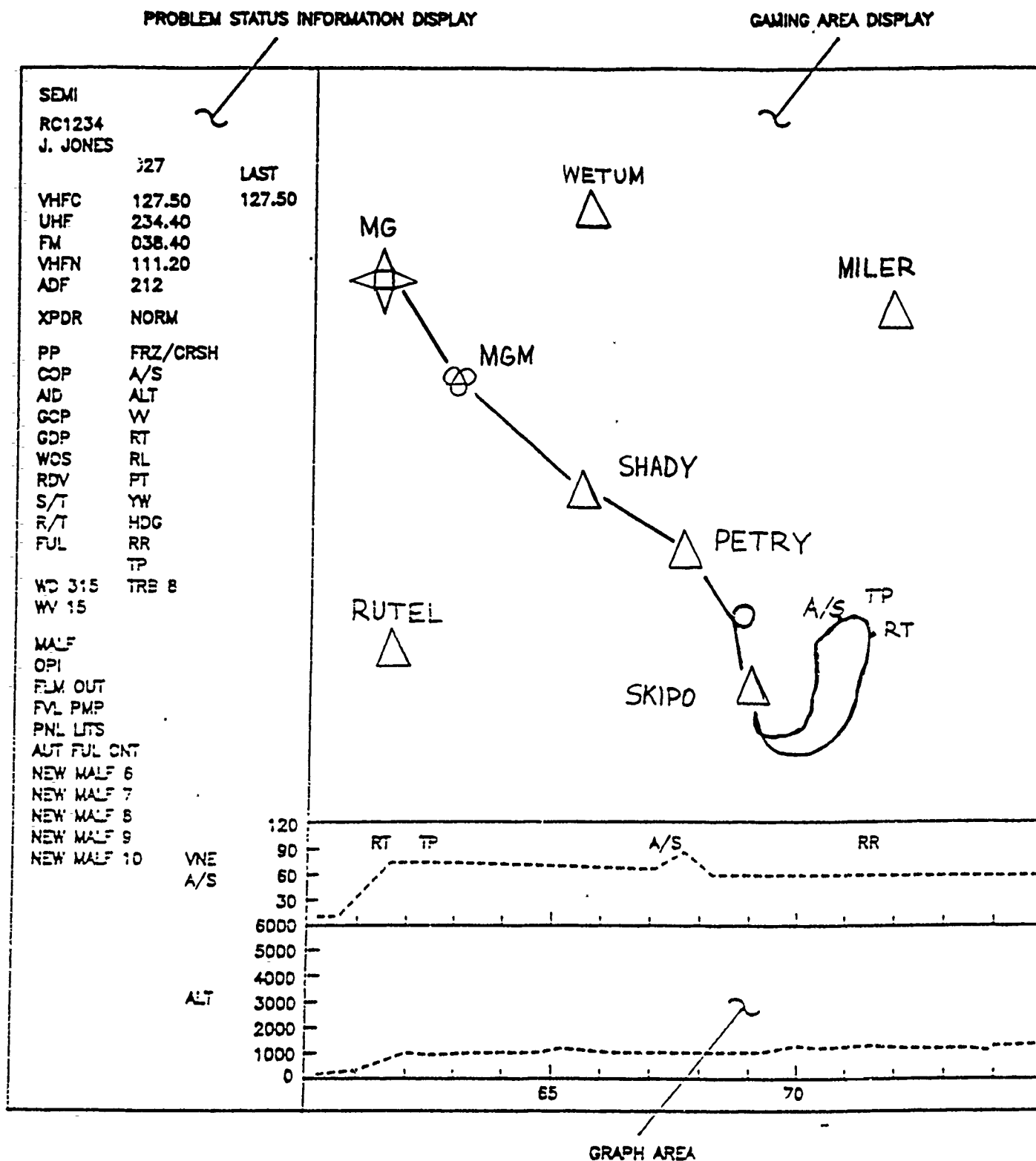
Figure 3-36. Cross Country Map.

3-77

Figure 3-37. Cross Country Map CID.

2: Cockpit
4: Cockpit
6: Cross Country Map Scale
8: Longitude
   Latitude
10: Longitude
    Latitude
12: Navigational Facilities
13: Cross Country Map
15: Cross Country Map

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3.2.1.5 Approach Map

The Approach Map is a 25 x 25 scale map of the navaids located at a particular airport. It appears on the Cockpit CRT or AID. The system maintains 9 area maps for a given area. An Approach Map with GCA Information is a GCA Map. An example of an Approach Map appears in Figure 38. The Approach Map class is depicted in Figure 39.

ATTRIBUTES

    1. Navigational Facilities

IMPORTED DATA

    1. Approach Map Area
    2. Navigational Facilities

EXPORTED DATA

    1. Approach Map

PROCESSING

    1. There are nine Approach Maps:

Map Number	Map Name
1	Marianna
2	Dothan
3	Montgomery/Donnelly Field
4	Cairns, Lowe, Enterprise, Hanchey
5	Columbus Metro
6	Lawson AFB
7	Troy Municipal
8	Tallahassee
9	Crestview

    2. Approach Maps are displayed at 25 x 25 scale.
    3. Approach lines must appear on the Approach Map.

INTERFACES

    1. The Approach Map consists of the approaches to a given landing area.
    2. The Navigational Facilities are read from a data base.
    3. The Approach Map appears in the map plot area of the Cockpit CRT or the AID.
    4. The Approach Map corresponding to the value of the AREA SEL thumbwheel switch is displayed on the Cockpit CRT when the PLOT AREA RCL push button on the Graphic Display Controls is depressed and the AREA SEL thumbwheel switch is set to a value greater than 0.
    5. The Approach Map corresponding to the value entered on the Numeric Keypad is displayed on the AID when the AREA push button on the AID Controls is depressed.

SEMI

RC1234

J. JONES

	027	LAST
VHFC	127.50	127.50
UHF	234.40	
FM	038.40	
VHFN	111.20	
ADF	212	

XPDR	NORM

PP	FRZ/CRSH
COP	A/S
AID	ALT
GCP	W
GDP	RT
WOS	RL
RDV	PT
S/T	YW
R/T	HDG
FUL	RR
	TP
WD 315	TRB 8
WV 15	

MALF
OPI
FLM OUT
FVL PMP
PNL LITS
AUT FUL CNT
NEW MALF 6
NEW MALF 7
NEW MALF 8
NEW MALF 9
NEW MALF 10

Figure 3-38. Approach Map.

3-80
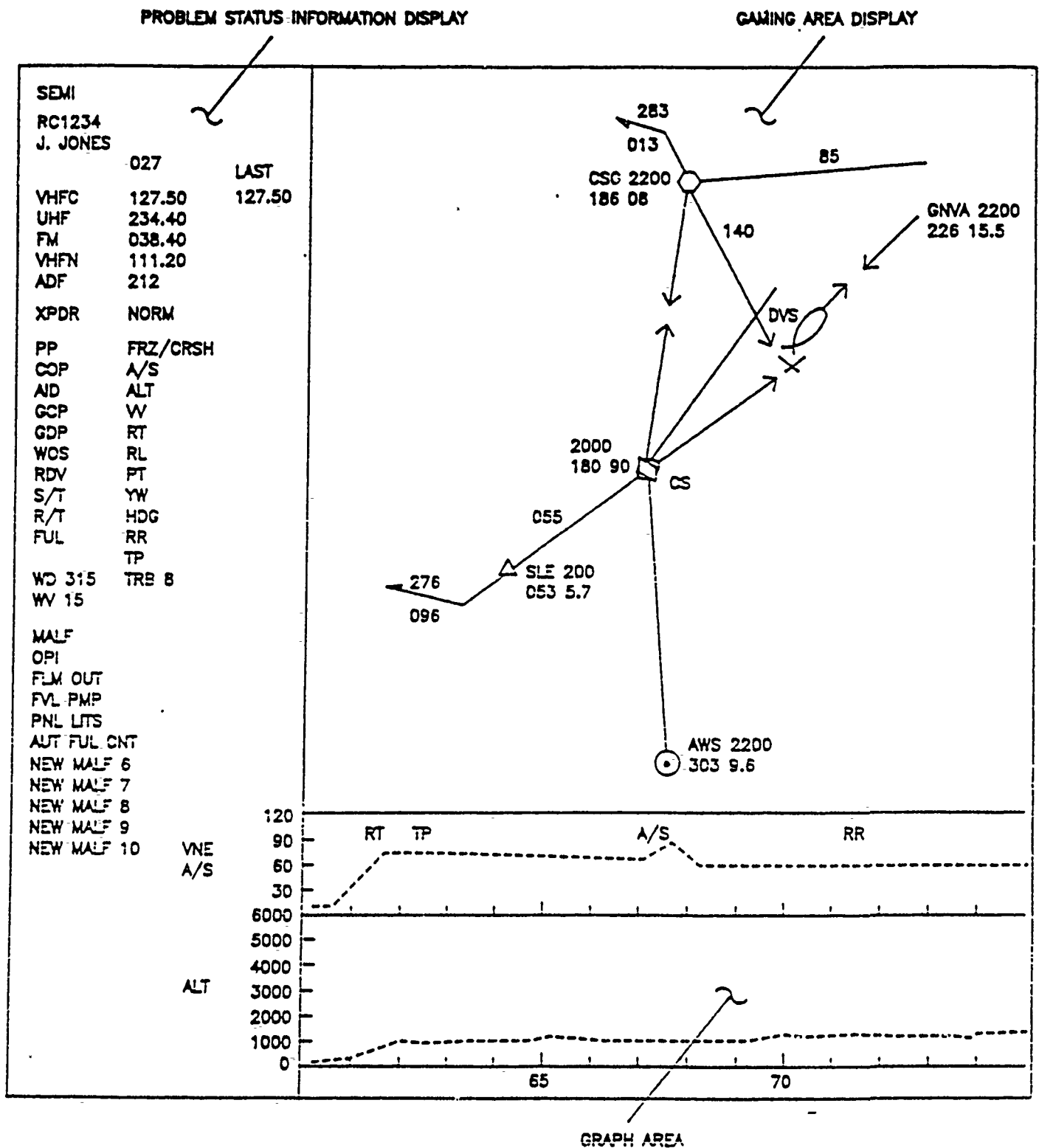
2: Approach Map Area
4: Approach Map Area
6: Navigational Facilities
7: Approach Map
9: Approach Map
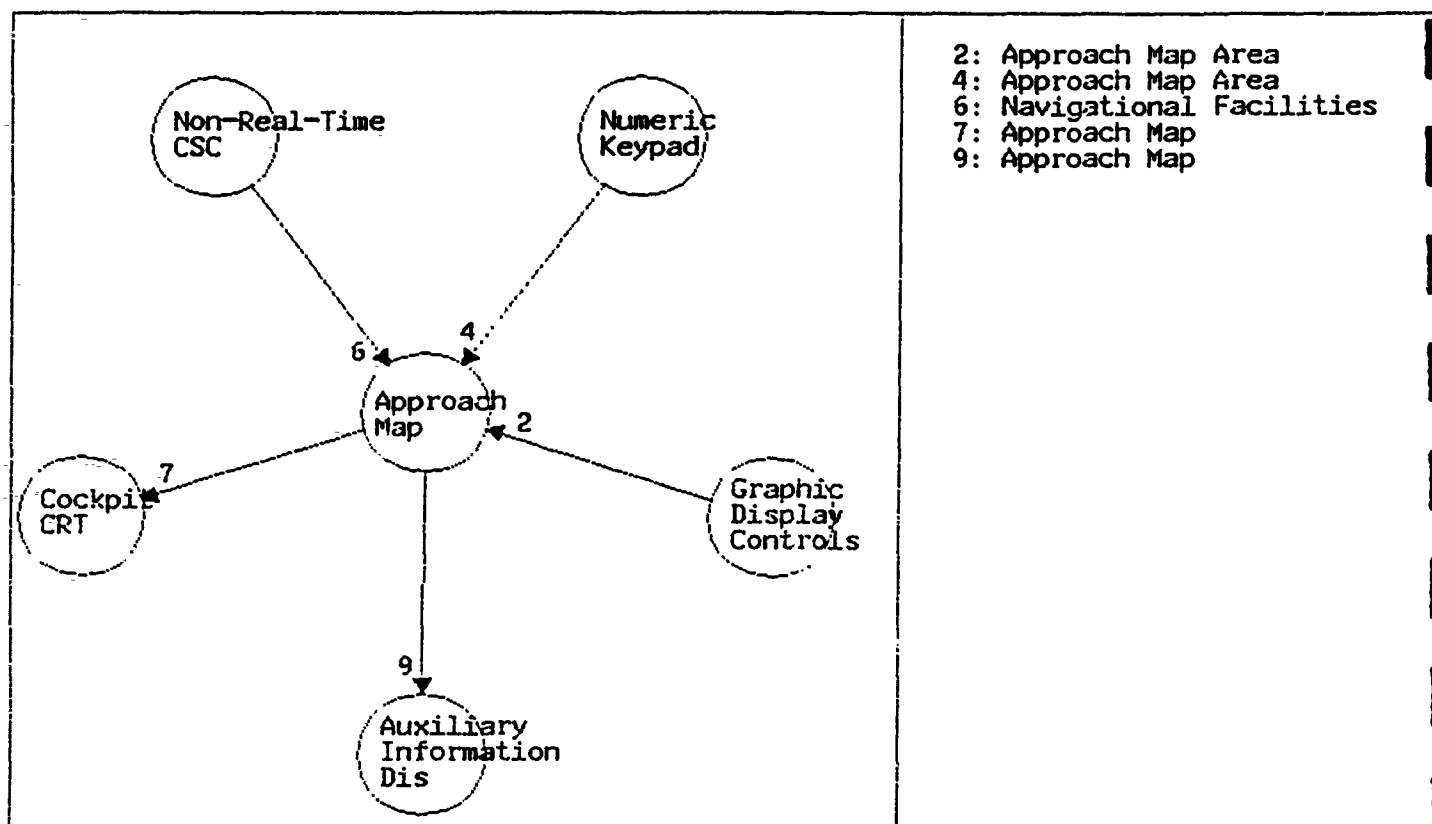
Figure 3-39. Approach Map CID.

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3.2.1.6 GCA Graph

The GCA Graph is comprised of a plot of elevation against range, and a plot of azimuth against range. It appears on the Cockpit CRT at one of two scales:

- 0 to 2.5 nautical miles,

- 0 to 10 nautical miles.

It also appears on the AID, the scale being 0 to 2.5 nautical miles. An example of a GCA Graph appears in Figure 40. The GCA Graph class is depicted in Figure 41.

ATTRIBUTES

    1. GCA Graph Scale
    2. Altitude
    3. Latitude
    4. Longitude
    5. Range

IMPORTED DATA

    1. Cockpit
    2. GCA Graph Scale
    3. Altitude
    4. Latitude
    5. Longitude
    6. Range

EXPORTED DATA

    1. GCA Graph

PROCESSING

    1. The GCA Graph consists of a glideslope trace and a course trace.
    2. The GCA Graph appears at one of the following scales:

       - 0 to 2.5 nautical miles,
       - 0 to 10 nautical miles.

    3. The default scale for the GCA Graph is 0 to 2.5 nautical miles.

INTERFACES

    1. The GCA Graph consists of the following components:

       - a display of the helicopter's approach and glidepath
       - GCA Information

    2. The GCA Graph receives the current Altitude, Latitude, Longitude, and Range from the Trainee

Station CSC.

3. The Cockpit for the GCA Graph appearing on the Cockpit CRT is entered on the Cockpit Display Select Controls.

4. The Cockpit for the GCA Graph appearing on the AID is entered on the Numeric Keypad.

5. The GCA Graph appears in the map plot area of the Cockpit CRT at any scale.

6. The GCA Graph appears on the AID at the default scale.

7. A GCA Graph at the 0 to 2.5 scale is displayed on the Cockpit CRT when the GCA COMM push button on the Graphic Display Controls is depressed and the AREA SEL thumbwheel switch is set to 1.

8. A GCA Graph at the 0 to 10 scale is displayed on the Cockpit CRT when the GCA COMM push button on the Graphic Display Controls is depressed and the AREA SEL thumbwheel switch is set to 2.

9. A GCA Graph at the default scale is displayed on the AID when the GCA push button on the AID Controls is depressed.

Figure 3-40. GCA Graph.
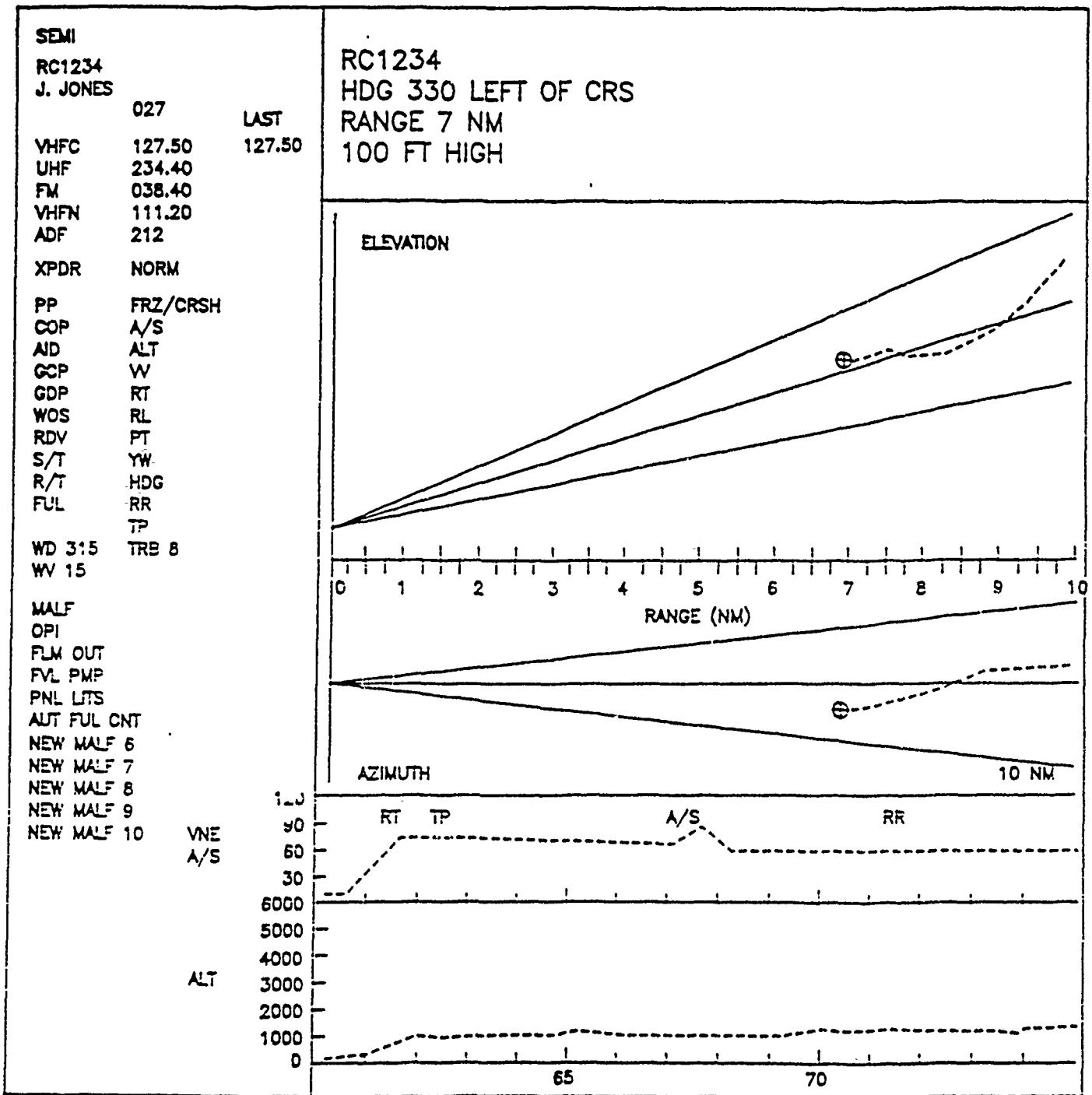
2: Range
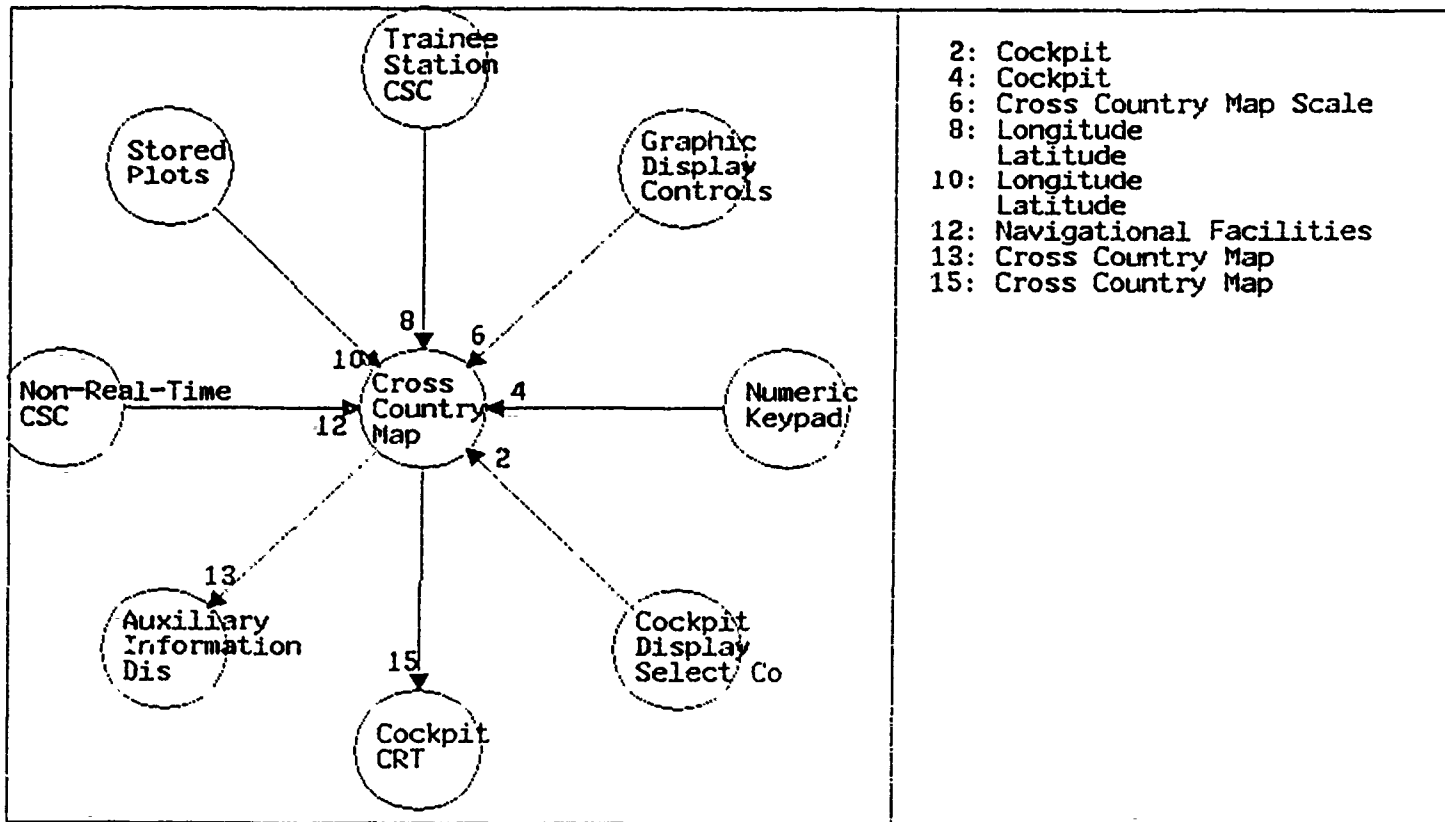   Longitude
   Latitude
   Altitude
4: Cockpit
6: Cockpit
8: GCA Graph Scale
9: GCA Graph
11: GCA Graph
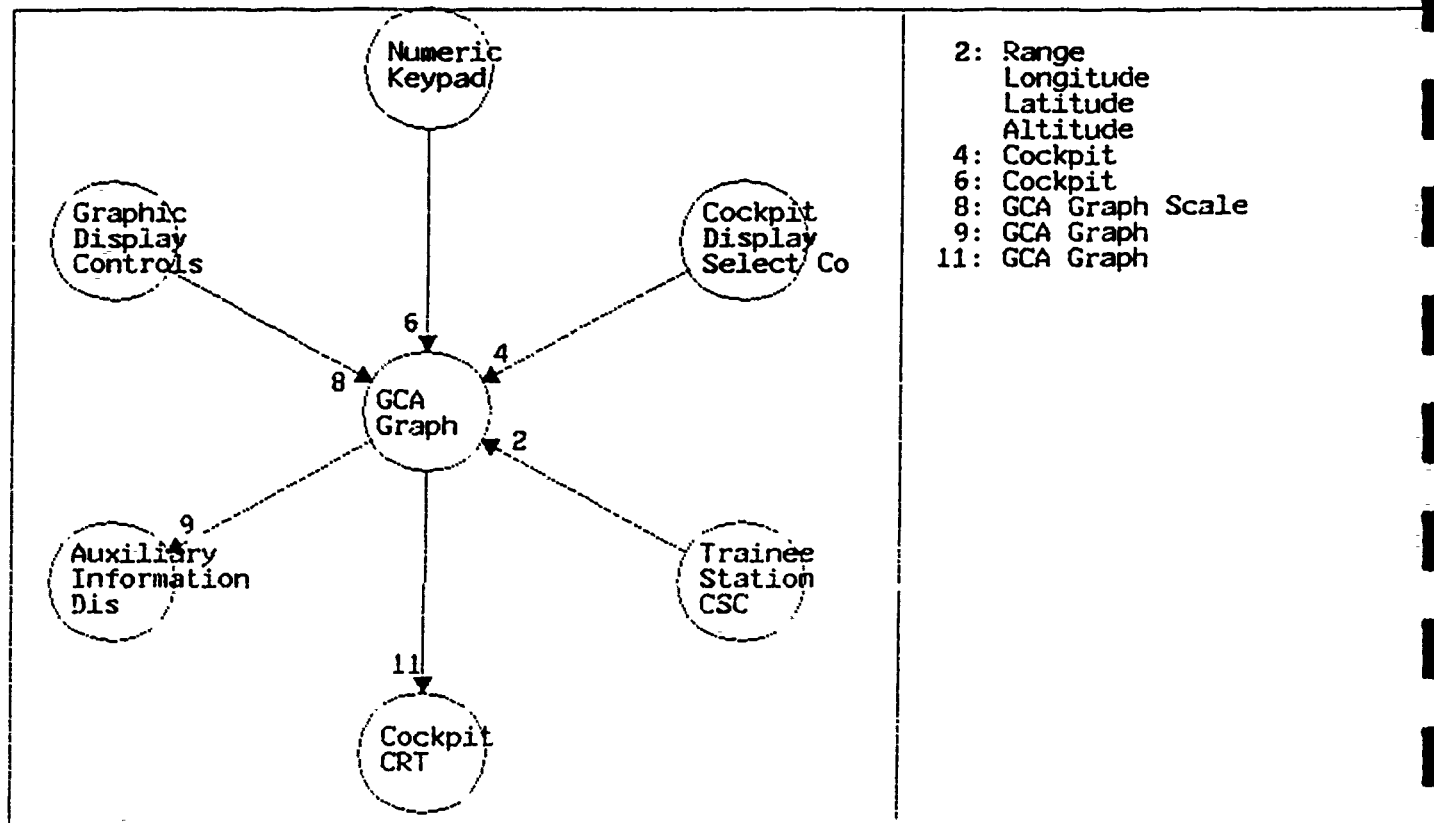
Figure 3-41. GCA Graph CID.

3.2.1.7 Ground Track

The Ground Track is a plot of the simulated latitude and longitude of the helicopter for up to the last 8 to 51 minutes of flight. The length of time covered by the Ground Track depends on the scale of the map on which it appears. The Ground Track is displayed on both the Cross Country Map. It appears on the Cockpit CRT at one of three scales within the specified time:

- 12.5 x 12.5 nautical miles   (8 minutes)

- 25 x 25 nautical miles   (15 minutes)

- 100 x 100 nautical miles   (51 minutes)

It also appears on the AID, the scale being the entire gaming area. For a pictorial representation of a Ground Track, see Figure 36. The Ground Track class is depicted in Figure 42.

ATTRIBUTES

1. Latitude
2. Longitude

IMPORTED DATA

1. Cockpit
2. Cross Country Map Scale
3. Latitude
4. Longitude

EXPORTED DATA

1. Ground Track

PROCESSING

1. The default scale for the Ground Track is the same as for the corresponding map.
2. If the trainer is not in a freeze state, the aircraft is identified by a flashing aircraft symbol.
3. If the trainer is in a freeze state, the aircraft is identified by a non-flashing aircraft symbol.
4. The aircraft is positioned in the center of the map plot area.
5. Five-minute time ticks are displayed at the right-hand side of the Ground Track.
6. Up to the most recent 15 minutes of the flight path are stored for use in playback.
7. Depending on the current scale, requirements for the maximum amount of Ground Track displayed at any time are:

Scale	Time
12.5 x 12.5 nm	8 min
25 x 25 nm	15 min
100 x 100 nm	51 min

8. The Ground Track must store Latitude and Longitude for up to 105 minutes of simulated flight.

9. If the flight time in the current display area is less than the required time for the current scale, the entire portion of the Ground Track must be displayed.
10. Otherwise, the oldest portions of the flight path need not be displayed.
11. The Ground Track is erased starting with the oldest portions displayed.
12. Erasure is stopped when a second stimulus arrives.
13. Five minute time ticks are not erased.
14. Any portions of the Ground Track that have been erased are redisplayed if a new Cross Country Map is displayed.
15. If the entire Ground Track has been erased and the ground track erase is still on, only the aircraft symbol is displayed, with no ground track.

INTERFACES

1. The Ground Track is updated with the current Latitude and Longitude from the Trainee Station CSC.
2. The Cockpit for the Ground Track appearing on the Cockpit CRT is entered on the Cockpit Display Select Controls.
3. The Cockpit for the Ground Track appearing on the AID is entered on the Numeric Keypad.
4. The Ground Track is displayed on the Cockpit CRT at system startup, when the SEMI AUTO push button on the Mode Controls is depressed.
5. The Ground Track is displayed on the Cockpit CRT when the PLOT AREA RCL push button on the Graphic Display Controls is depressed and the AREA SEL thumbwheel switch is set to 0.
6. The Ground Track is notified of a change in Cross Country Map Scale when the GTRK 12.5 X 12.5, GTRK 25 X 25, or GTRK 100 X 100 push button on the Graphic Display Controls is depressed.
7. Ground Track erasing is started when the GND TRK ERASE push button on the Graphic Display Controls is depressed while erasing is not in progress.
8. Ground Track erasing is stopped when the GND TRK ERASE push button on the Graphic Display Controls is depressed while erasing is in progress.
9. The Ground Track is displayed on the AID when the CROSS CNTRY push button on the AID Controls is depressed.

2: Cockpit
4: Cockpit
6: Cross Country Map Scale
8: Longitude
   Latitude
10: Longitude
    Latitude
11: Ground Track
13: Ground Track
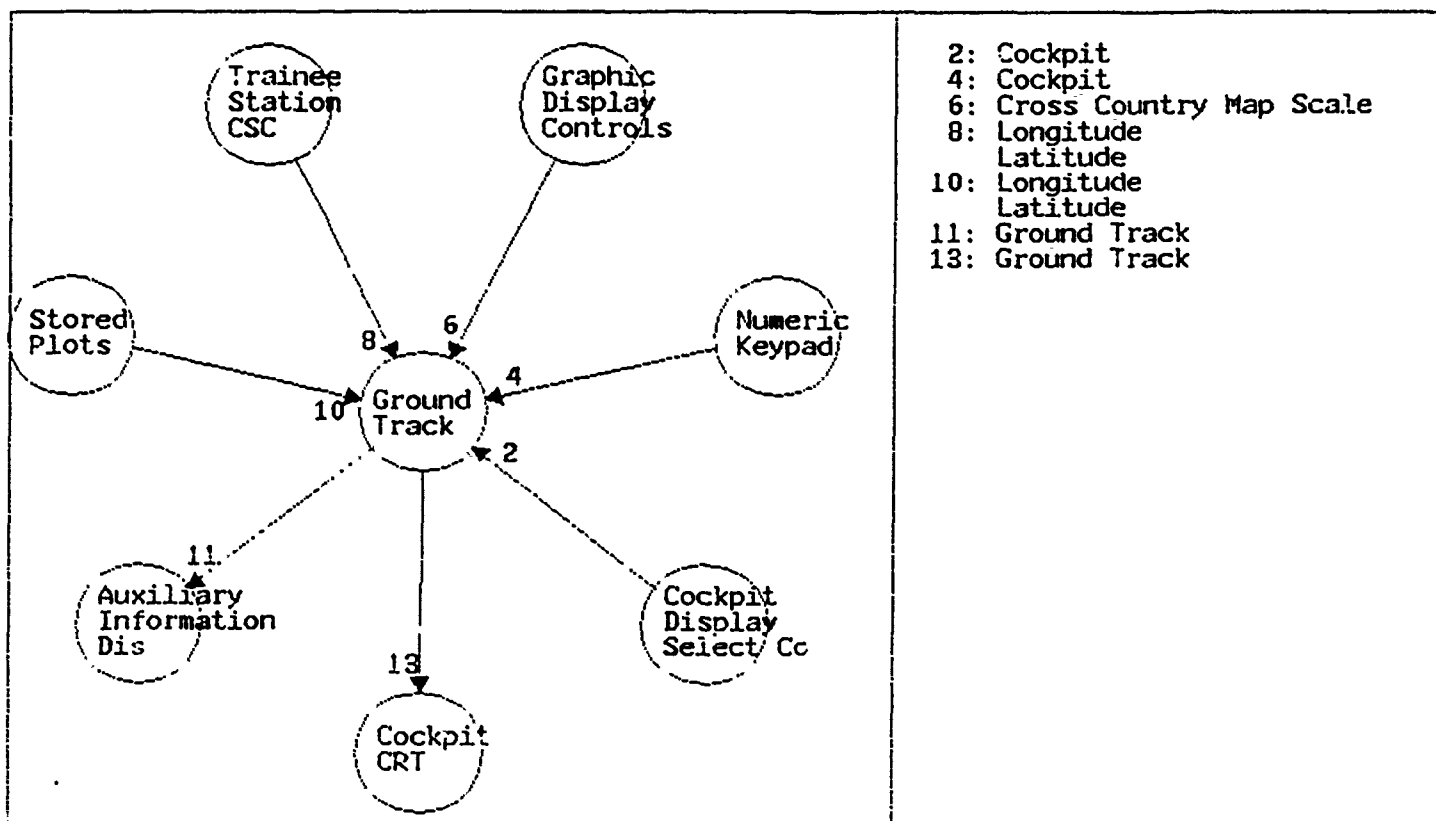
Figure 3-42. Ground Track CID.

3.2.1.8 Visual Error Alerts

Visual Error Alerts are error symbols for out-of-tolerance flight conditions. The symbols appear above and to the left of the Ground Track in the map plot area. For a pictorial representation of the Visual Error Alerts, see Figure 36. The Visual Error Alerts class in depicted in Figure 43.

ATTRIBUTES

1. Altitude
2. Air Speed
3. Heading
4. Roll
5. Pitch
6. Yaw
7. Vertical Velocity
8. Rate of Turn
9. Torque Pressure
10. Glide Path Deviation
11. Course Deviation

IMPORTED DATA

1. Cockpit
2. Error

EXPORTED DATA

1. Visual Error Alerts

PROCESSING

1. Visual Error Alerts are displayed when audio alert messages are triggered.
2. While the audio alert message for a given error is cued, the Visual Error Alert will flash.
3. When the audio cue is completed, the Visual Error Alert is displayed in high intensity.
4. Once an error has been corrected, the Visual Error Alert is redisplayed in normal intensity.
5. Possible Visual Error Alerts and their abbreviations are as follows:

Symbol	Alert
CR DEV	Course deviation
G/S	Glide slope deviation
ALT	Altitude
A/S	Air speed
HDG	Heading
RL	Roll
PT	Pitch
YW	Yaw
VV	Vertical velocity
RT	Rate of turn
TP	Torque pressure

6. Visual Eror Alerts are erased starting with the oldest portions displayed.

INTERFACES

1. Visual Error Alerts are updated with the current Error from the Trainee Station CSC.
2. The Cockpit for Visual Error Alerts appearing on the Cockpit CRT is entered on the Cockpit Display Select Controls.
3. The Cockpit for Visual Error Alerts appearing on the AID is entered on the Numeric Keypad.
4. Visual Error Alerts are displayed on the Cockpit CRT at system startup, when the SEMI AUTO push button on the Mode Controls is depressed.
5. Visual Error Alerts are displayed on the Cockpit CRT when the PLOT AREA RCL push button on the Graphic Display Controls is depressed and the AREA SEL thumbwheel switch is set to 0.
6. Visual Error Alert erasing is started when the GND TRK ERASE push button on the Graphic Display Controls is depressed while erasing is not in progress.
7. Visual Error Alert erasing is stopped when the GND TRK ERASE push button on the Graphic Display Controls is depressed while erasing is in progress.
8. Visual Error Alerts are displayed on the AID when the CROSS CNTRY push button on the AID Controls is depressed.
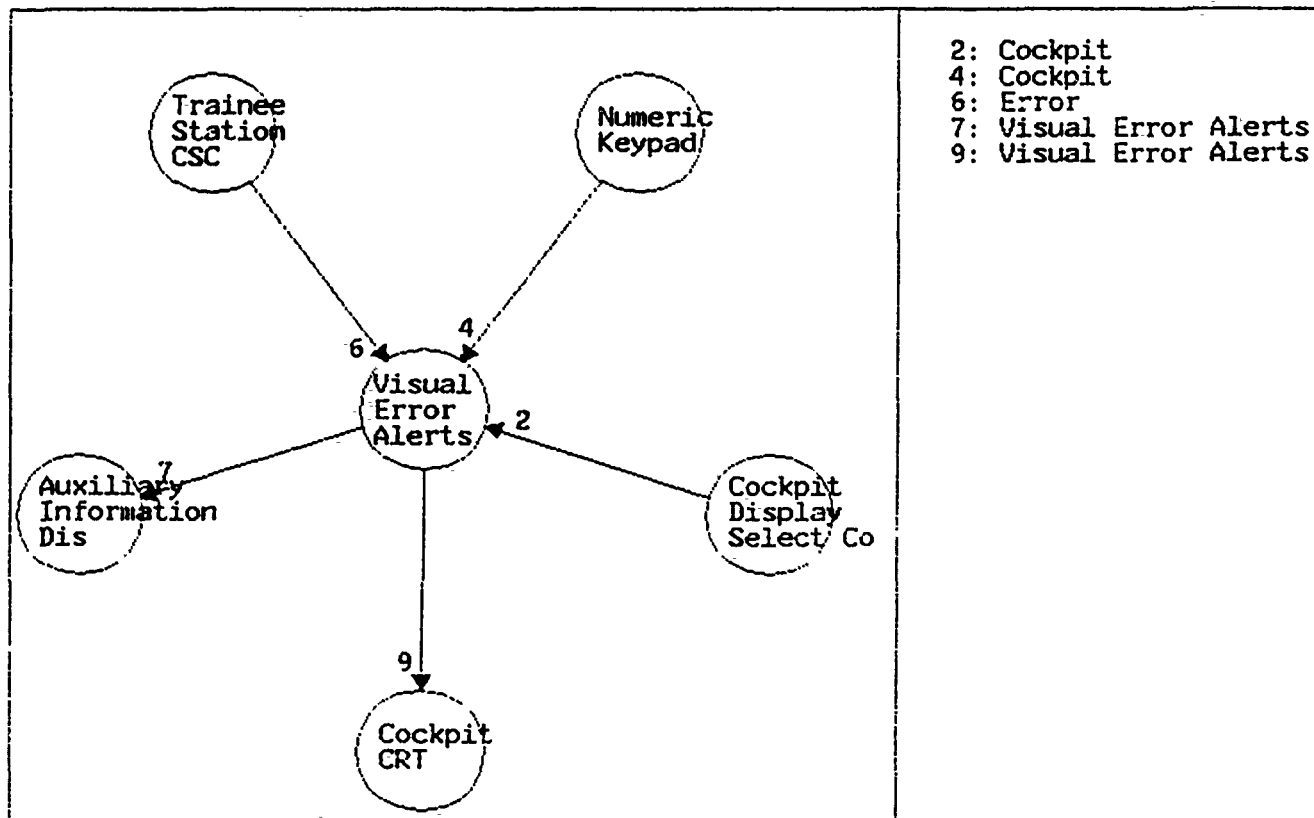
Figure 3-43. Visual Error Alerts CID.

3.2.1.9 GCA Information

GCA Information includes all ground-controlled information on the current simulated flight. It is displayed with the Approach Map to form a GCA Map. It is also used in the GCA Graph. It appears on the Cockpit CRT or the AID. For a pictorial representation of the GCA Information, see Figure 40. The GCA Information class is depicted in Figure 44.

ATTRIBUTES

1. Radio Call Number
2. Heading
3. Range
4. Altitude
5. Glide Path Deviation
6. Course Deviation

IMPORTED DATA

1. Cockpit
2. Radio Call Number
3. Heading
4. Range
5. Altitude
6. Latitude
7. Longitude

EXPORTED DATA

1. GCA Information

PROCESSING

1. GCA Information consists of the following items:

    * Aircraft call number
    * Heading
    * Range
    * Altitude

2. GCA Information is updated on the screen once every second.
3. GCA Information is not displayed if the aircraft is not within 10 degrees left or right of the on-course line and within 10 nautical miles of touchdown on the GCA runway.

INTERFACES

1. GCA Information is updated with the current Radio Call Number, Heading, Range, Altitude, Latitude, and Longitude from the Trainee Station CSC.
2. The Cockpit for GCA Information appearing on the Cockpit CRT is entered on the Cockpit Display Select Controls.
3. The Cockpit for GCA Information appearing on the AID is entered on the Numeric Keypad.
4. GCA Information is displayed on the Cockpit CRT when the GCA COMM push button on the

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Graphic Display Controls is depressed and the AREA SEL thumbwheel switch is set to 1 or 2.

5. GCA Information is displayed on the AID when the GCA push button on the AID Controls is depressed.

The diagram shows a GCA Information node connected to:
- Numeric Keypad (link 6)
- Cockpit Display Select Co (link 4)
- Auxiliary Information Dis (link 7)
- Trainee Station CSC (link 2)
- Cockpit CRT (link 9)

2: Range
   Radio Call Number
   Longitude
   Latitude
   Heading
   Altitude
4: Cockpit
6: Cockpit
7: GCA Information
9: GCA Information
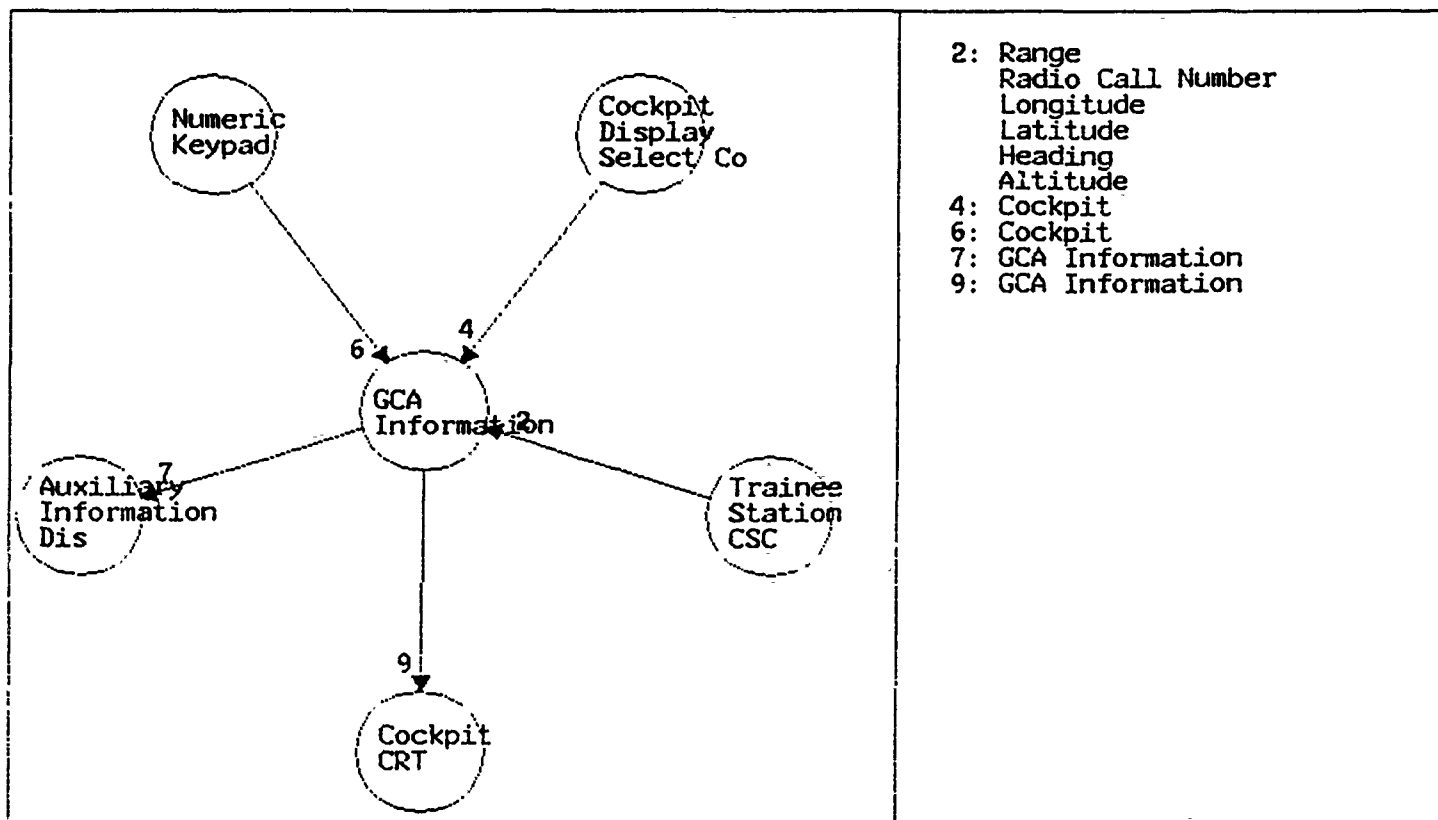
Figure 3-44. GCA Information CID.

3.2.2 EDITABLE DISPLAYS

This subsystem includes those classes that are edited to set up the problem to be simulated for the UH-1.

CLASSES

1. Initial Condition Sets
2. Flight Parameters
3. Malfunction Lists
4. Navaids

3.2.2.1 Initial Condition Sets

Initial Condition Sets (IC Sets) are sets of operating configurations and geographical locations for the simulated aircraft. Twenty predefined IC Sets will be available. Four user specified IC Sets (one per cockpit) will be available. User specified IC Sets are created by changing the desired values of an IC Set and saving the resulting IC Set. The Initial Condition Sets class is depicted in Figure 45.

ATTRIBUTES

1. Altitude
2. Air Speed
3. Heading
4. Roll
5. Pitch
6. Yaw
7. Vertical Velocity
8. Rate of Turn
9. Torque Pressure
10. Rotor RPM
11. Latitude
12. Longitude
13. Fuel Weight
14. Center of Gravity
15. Gross Weight
16. Barometric Pressure
17. Outside Air Temperature
18. Wind Velocity
19. Wind Direction
20. Turbulence Level
21. Sound Level
22. Static Level
23. Auxiliary Power Unit
24. Rate of Fuel Burn

IMPORTED DATA

1. Cockpit
2. Initial Condition Set Identifier
3. Initial Condition Setups
4. Altitude
5. Air Speed
6. Heading
7. Roll
8. Pitch
9. Yaw
10. Vertical Velocity
11. Rate of Turn
12. Torque Pressure
13. Rotor RPM
14. Latitude
15. Longitude

16. Fuel Weight
17. Center of Gravity
18. Gross Weight
19. Barometric Pressure
20. Outside Air Temperature
21. Wind Velocity
22. Wind Direction
23. Turbulence Level
24. Sound Level
25. Static Level
26. Auxiliary Power Unit
27. Rate of Fuel Burn

EXPORTED DATA

1. Initial Condition Set

PROCESSING

1. There are 19 predetermined Initial Condition Sets.
2. An Initial Condition Set can be assigned to a cockpit either as is or after modification of one or more of its values.
3. The following possible error conditions must be handled:

   • User enters a value for any element of the IC Set that exceeds its allowable maximum value.

INTERFACES

1. Initial Condition Setups are read from a data base.
2. Initial Condition Sets are modified at the AID Control Panel.
3. The Cockpit and the Initial Condition Set Identifier are entered on the Numeric Keypad.
4. Updated Initial Condition Sets are sent to the Trainee Station CSC.
5. The appropriate Initial Condition Set is used to initialize the Flight Parameters when either of the following occurs:

   • the PROB RESET push button on the Flight Controls is depressed
   • the RESET push button on the Problem Controls is depressed

6. The Initial Condition Set for the appropriate cockpit is displayed in the cockpit display area of the AID when either of the following occurs:

   • the CKPT 1 AREA, CKPT 2 AREA, CKPT 3 AREA, or CKPT 4 AREA and the INIT COND push buttons on the AID Controls are depressed
   • the 1, 2, 3, or 4 push button on the AID Controls is depressed while the Initial Condition Set is in the edit area of the AID

7. The Initial Condition Set for the cockpit entered on the Numeric Keypad is displayed in the edit area of the AID when either of the following occurs:

   • the EDIT AREA and INIT COND push buttons on the AID Controls are depressed
   • the 1, 2, 3, or 4 push button on the AID Controls is depressed while the Initial Condition Set is in the cockpit display area of the AID
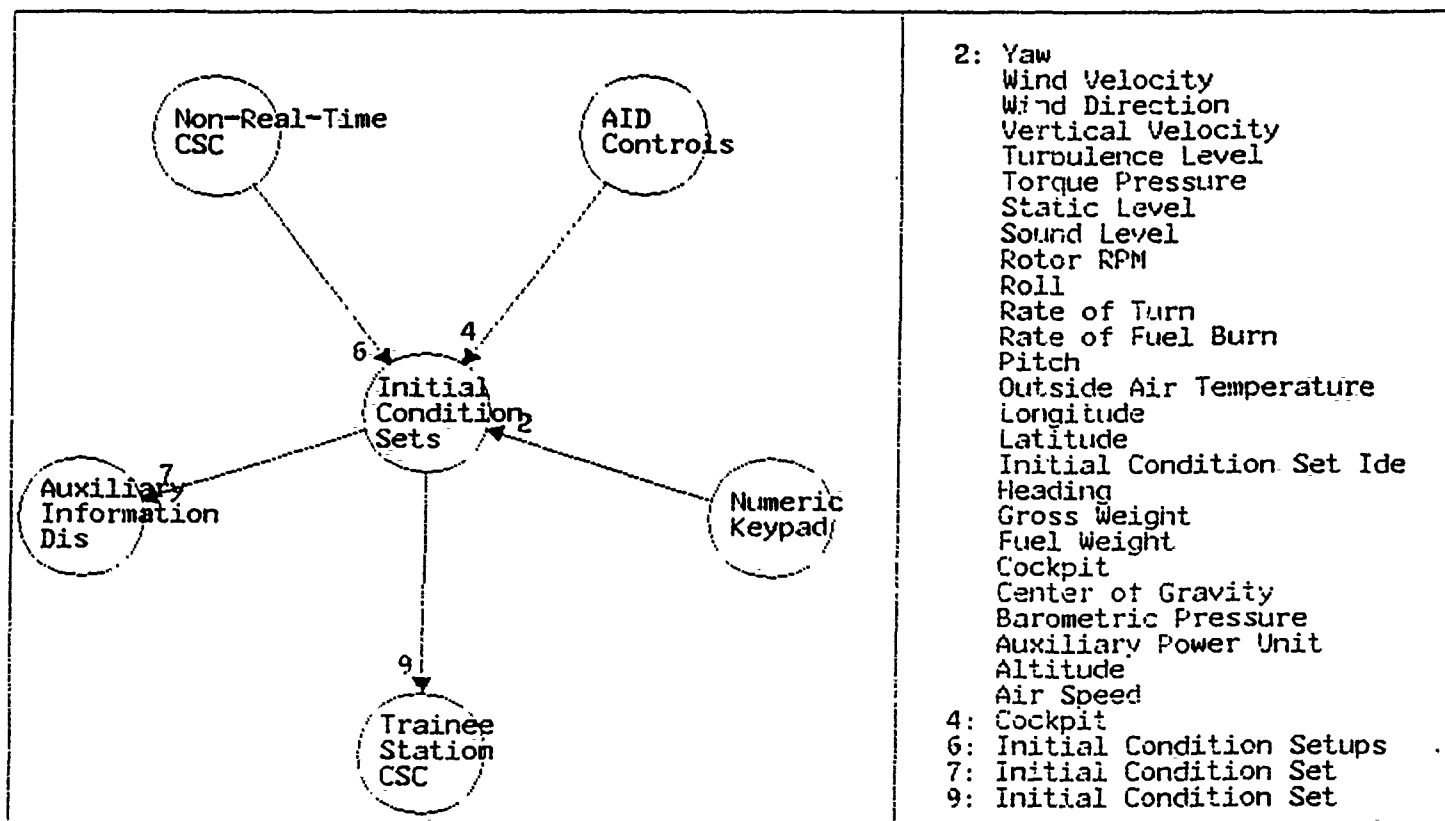
Figure 3-45. Initial Condition Sets CID.

3.2.2.2 Flight Parameters

The flight parameter list describes 24 characteristics of the current flight of the aircraft. Ten of the flight parameters can be frozen; the other 14 can be modified at any time during the flight. The Flight Parameters class is depicted in Figure 46.

ATTRIBUTES

1. Altitude
2. Air Speed
3. Heading
4. Roll
5. Pitch
6. Yaw
7. Vertical Velocity
8. Rate of Turn
9. Torque Pressure
10. Rotor RPM
11. Latitude
12. Longitude
13. Fuel Weight
14. Center of Gravity
15. Gross Weight
16. Barometric Pressure
17. Outside Air Temperature
18. Wind Velocity
19. Wind Direction
20. Turbulence Level
21. Sound Level
22. Static Level
23. Auxiliary Power Unit
24. Rate of Fuel Burn

IMPORTED DATA

1. Cockpit
2. Flight Parameter Identifier
3. Altitude
4. Air Speed
5. Heading
6. Roll
7. Pitch
8. Yaw
9. Vertical Velocity
10. Rate of Turn
11. Torque Pressure
12. Rotor RPM
13. Latitude
14. Longitude
15. Fuel Weight
16. Center of Gravity

17. Gross Weight
18. Barometric Pressure
19. Outside Air Temperature
20. Wind Velocity
21. Wind Direction
22. Turbulence Level
23. Sound Level
24. Static Level
25. Auxiliary Power Unit
26. Rate of Fuel Burn

EXPORTED DATA

1. Flight Parameter List

PROCESSING

1. Flight Parameters can be edited in the following ways:

   - The value of the Flight Parameter may be modified.
   - The Flight Parameter may be frozen. This means that its value cannot change until it is restored.
   - The Flight Parameter may be restored.

2. When Flight Prameter is frozen an F will be placed beside it. When the parameter is restored the F will disappear.
3. The following Flight Parameters can be frozen:

   - Altitude
   - Air Speed
   - Heading
   - Roll
   - Pitch
   - Yaw
   - Vertical Velocity
   - Rate of Turn
   - Torque Pressure
   - Rotor RPM

4. All Flight Parameters can be updated by the IOS.
5. The following Flight Parameters can be updated by the trainer:

   - Altitude
   - Air Speed
   - Heading
   - Roll
   - Pitch
   - Yaw
   - Vertical Velocity
   - Rate of Turn
   - Torque Pressure
   - Rotor RPM

- Latitude
- Longitude
- Fuel Weight

INTERFACES

1. Flight Parameters are continually updated by the Trainee Station CSC during simulated flight.
2. Flight Parameters can also be modified at the AID Control Panel.
3. The Cockpit and the Flight Parameter Identifier are entered on the Numeric Keypad.
4. Flight Parameters modified at the AID are sent to the Trainee Station CSC.
5. The Flight Parameters are initialized with the values from the appropriate Initial Condition Set when either of the following occurs:

   - the PROB RESET push button on the Flight Controls is depressed
   - the RESET push button on the Problem Controls is depressed

6. Turbulence Level is set to the value of the DEMO thumbwheel switch when the MALF push button on the Problem Controls is depressed and the PROB thumbwheel switch is set to 0.
7. The Flight Parameters for the appropriate cockpit are displayed in the cockpit display area of the AID when either of the following occurs:

   - the CKPT 1 AREA, CKPT 2 AREA, CKPT 3 AREA, or CKPT 4 AREA and the FLT PRMTR push buttons on the AID Controls are depressed
   - the 1, 2, 3, or 4 push button on the AID Controls is depressed while the Flight Parameters are in the edit area of the AID

8. The Flight Parameters for the cockpit entered on the Numeric Keypad are displayed in the edit area of the AID when either of the following occurs:

   - the EDIT AREA and FLT PRMTR push buttons on the AID Controls are depressed
   - the 1, 2, 3, or 4 push button on the AID Controls is depressed while the Flight Parameters are in the cockpit display area of the AID

9. Flight Parameters are frozen when the FLT PRMTR FRZ push button on the AID Controls is depressed.
10. Flight Parameters are unfrozen when the FLT PRMTO RSTRE push button on the AID Controls is depressed.
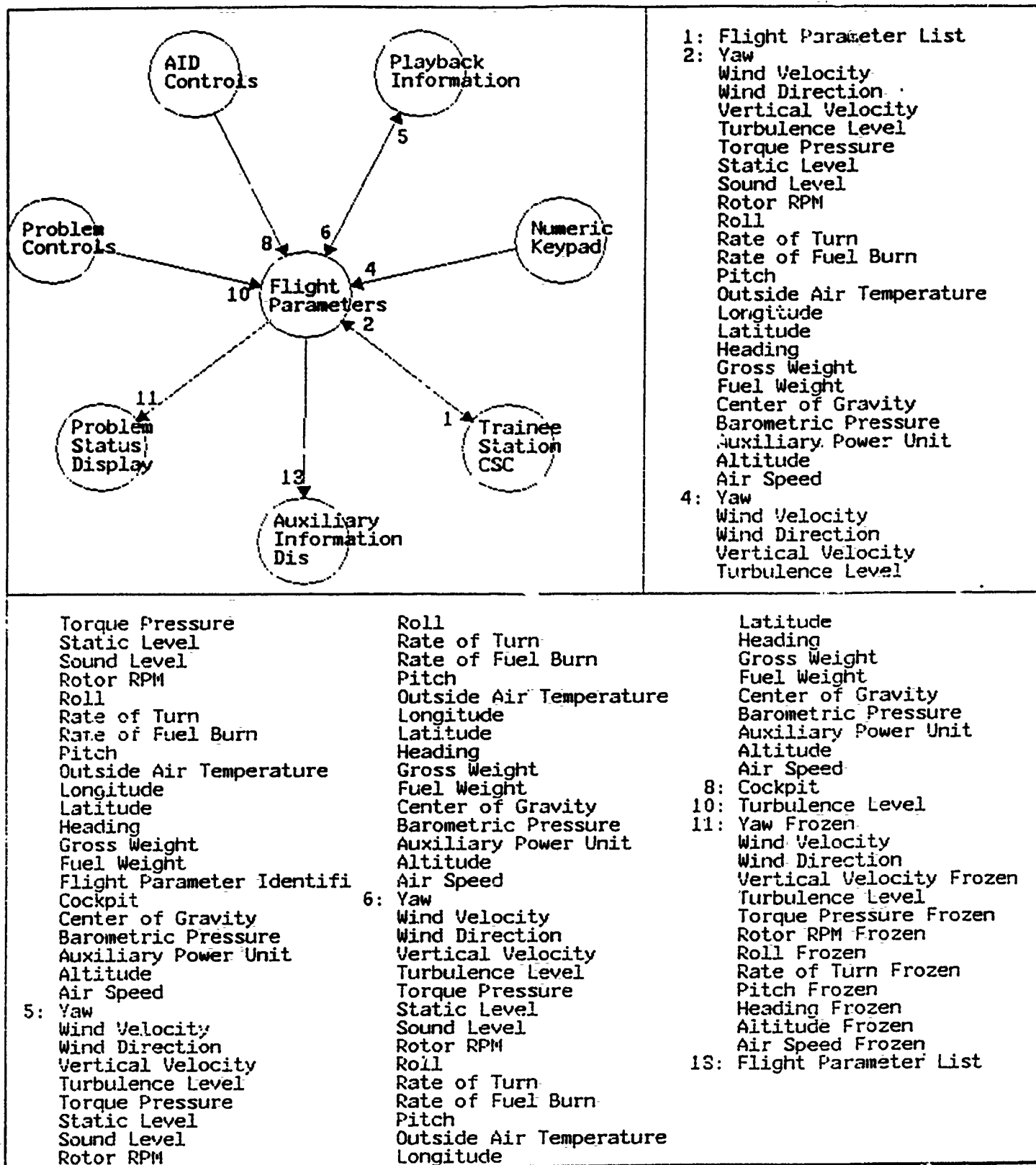
Figure 3-46. Flight Parameters CID.

1: Flight Parameter List
2: Yaw
   Wind Velocity
   Wind Direction
   Vertical Velocity
   Turbulence Level
   Torque Pressure
   Static Level
   Sound Level
   Rotor RPM
   Roll
   Rate of Turn
   Rate of Fuel Burn
   Pitch
   Outside Air Temperature
   Longitude
   Latitude
   Heading
   Gross Weight
   Fuel Weight
   Center of Gravity
   Barometric Pressure
   Auxiliary Power Unit
   Altitude
   Air Speed
4: Yaw
   Wind Velocity
   Wind Direction
   Vertical Velocity
   Turbulence Level

Torque Pressure
Static Level
Sound Level
Rotor RPM
Roll
Rate of Turn
Rate of Fuel Burn
Pitch
Outside Air Temperature
Longitude
Latitude
Heading
Gross Weight
Fuel Weight
Flight Parameter Identifi
Cockpit
Center of Gravity
Barometric Pressure
Auxiliary Power Unit
Altitude
Air Speed
5: Yaw
Wind Velocity
Wind Direction
Vertical Velocity
Turbulence Level
Torque Pressure
Static Level
Sound Level
Rotor RPM

Roll
Rate of Turn
Rate of Fuel Burn
Pitch
Outside Air Temperature
Longitude
Latitude
Heading
Gross Weight
Fuel Weight
Center of Gravity
Barometric Pressure
Auxiliary Power Unit
Altitude
Air Speed
6: Yaw
Wind Velocity
Wind Direction
Vertical Velocity
Turbulence Level
Torque Pressure
Static Level
Sound Level
Rotor RPM
Roll
Rate of Turn
Rate of Fuel Burn
Pitch
Outside Air Temperature
Longitude

Latitude
Heading
Gross Weight
Fuel Weight
Center of Gravity
Barometric Pressure
Auxiliary Power Unit
Altitude
Air Speed
8: Cockpit
10: Turbulence Level
11: Yaw Frozen
    Wind Velocity
    Wind Direction
    Vertical Velocity Frozen
    Turbulence Level
    Torque Pressure Frozen
    Rotor RPM Frozen
    Roll Frozen
    Rate of Turn Frozen
    Pitch Frozen
    Heading Frozen
    Altitude Frozen
    Air Speed Frozen
13: Flight Parameter List

3.2.2.3 Malfunction Lists

A Malfunction List is a subset of the data base of 107 malfunctions. A malfunction list is created for each cockpit through a series of editing operations at the AID. The Malfunction List contains up to 10 malfunctions which may be enabled for a given cockpit during a simulated flight.

Each malfunction in the malfunction list is either enabled or disabled. Each malfunction also has an associated (user-entered) time which represents how many minutes into the simulated flight the malfunction will be automatically enabled. If the time is omitted on entry, the malfunction will only be enabled from the cockpit or IOS, not automatically.

The Malfunction List class is depicted in Figure 47.

ATTRIBUTES

1. Malfunction Identifier List
2. Malfunction Status List
3. Time of Enablement List

IMPORTED DATA

1. Cockpit
2. Malfunction Identifier
3. Malfunctions
4. Malfunction Status
5. Time of Enablement

EXPORTED DATA

1. Malfunction List

PROCESSING

1. Malfunctions fall into the following categories:

   - Indicator Malfunction
   - Circuit Breaker Malfunction
   - Collective Malfunction
   - Cyclic Malfunction
   - Pedal Malfunction
   - Engine Malfunction
   - Transmission Malfunction
   - Main Rotor Malfunction
   - Tail Rotor Malfunction
   - Generator Malfunction
   - Inverter Malfunction
   - Boost Pump Malfunction

2. The Malfunction List stores up to 10 active malfunctions.
3. The user may enable any of the malfunctions in the Malfunction List.
4. The user may also enter an enablement time for a malfunction.

5. Malfunctions will be added to the end of the Malfunction List.
6. Duplicate malfunctions are allowed.
7. When a malfunction is replaced, its activation time is replaced with the activation time of the new malfunction.
8. The following possible error conditions must be handled:

   • User enters a value for a timed malfunction that is negative or out of range.
   • User enters a value greater than the current length of the Malfunction List as the malfunction to be replaced.
   • User enters an activated malfunction.
   • The Malfunction List contains no malfunctions.

INTERFACES

1. Malfunctions are read from a data base.
2. Malfunction Lists are created at the AID Control Panel.
3. The Cockpit and the Malfunction Identifier are entered on the Numeric Keypad.
4. Malfunctions can be enabled at three locations:

   • the Trainee Station Control Panel
   • the AID Control Panel
   • the Problem Control Panel

5. Updated Malfunction Lists are sent to the following destinations:

   • the Problem Status Display
   • the Trainee Station CSC

6. The Malfunction corresponding to the value of the SEL thumbwheel switch is enabled when the INSR push button on the Malfunction Controls is depressed.
7. The Malfunction corresponding to the value of the SEL thumbwheel switch is disabled when the INHB RMV push button on the Malfunction Controls is depressed.
8. The Malfunction corresponding to the value of the PROB thumbwheel switch is enabled when the MALF push button on the Problem Controls is depressed and the PROB thumbwheel switch is set to a value greater than 0 while the Malfunction is disabled.
9. The Malfunction corresponding to the value of the PROB thumbwheel switch is disabled when the MALF push button on the Problem Controls is depressed and the PROB thumbwheel switch is set to a value greater than 0 while the Malfunction is enabled.
10. The Malfunction List for the appropriate cockpit is displayed in the cockpit display area of the AID when either of the following occurs:

    • the CKPT 1 AREA, CKPT 2 AREA, CKPT 3 AREA, or CKPT 4 AREA and the FAIL push buttons on the AID Controls are depressed
    • the 1, 2, 3, or 4 push button on the AID Controls is depressed while the Malfunction List is in the edit area of the AID

11. The Malfunction List for the cockpit entered on the Numeric Keypad is displayed in the edit area of the AID when either of the following occurs:

    • the EDIT AREA and FAIL push buttons on the AID Controls are depressed
    • the 1, 2, 3, or 4 push button on the AID Controls is depressed while the Malfunction List is in the cockpit display area of the AID
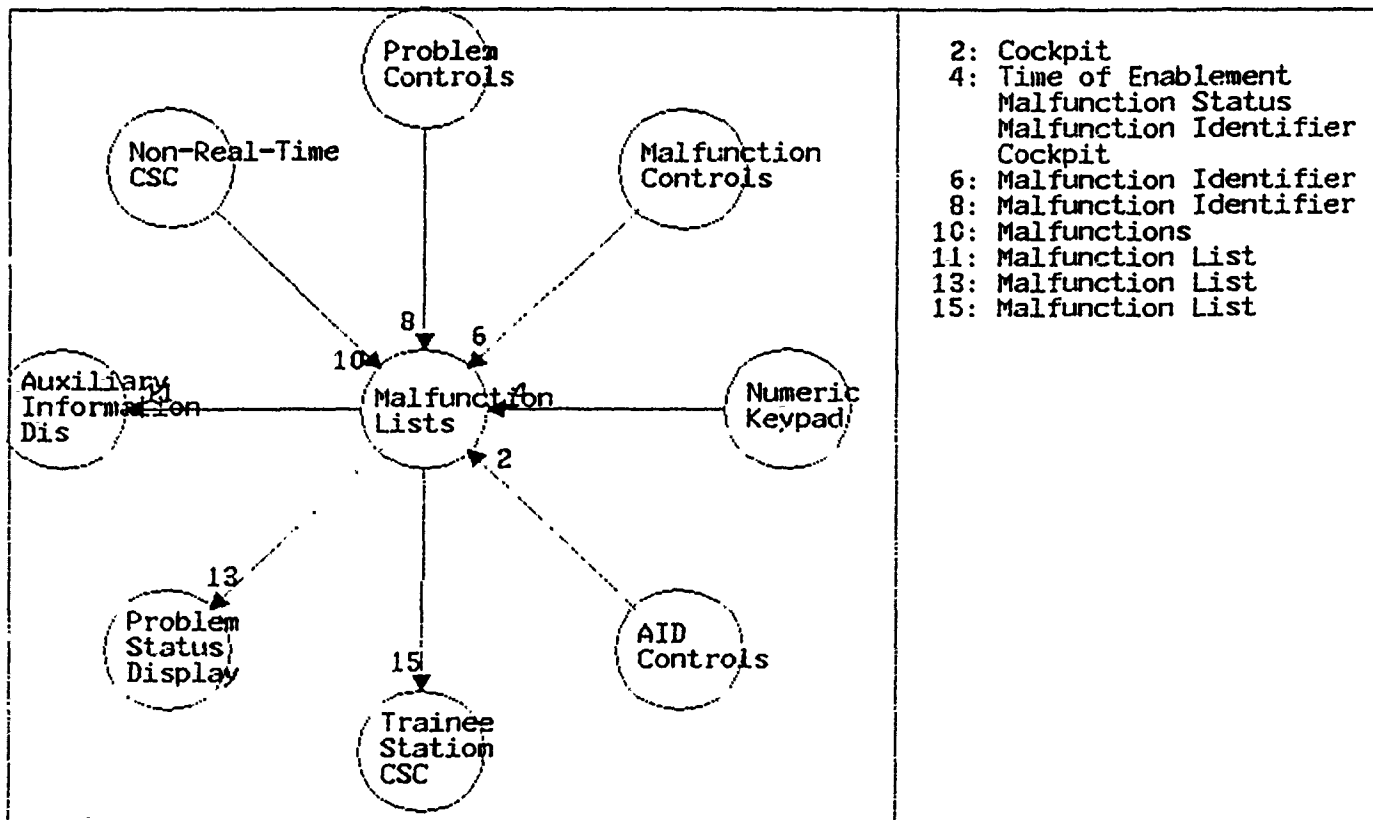
Figure 3-47. Malfunction Lists CID.

3.2.2.4 Navaids

The Navaids are a data base of navigational facility information. Each navigational facility can be enabled or disabled from the IOS. The Navaids class is depicted in Figure 48.

ATTRIBUTES

1. Facility Status List

IMPORTED DATA

1. Facility Identifier
2. Navigational Facilities
3. Facility Status

EXPORTED DATA

1. Navaid List

PROCESSING

1. Navaids fall into the following categories:

   - ADF Status
   - VOR Status
   - FM Status
   - TACAN Status
   - ILS Status
   - GCA Status

2. Facilities can be enabled and disabled.
3. The displayed list of facilities indicates the current status of each facility--enabled or disabled.
4. If the user selects a station identifier from a displayed list, the attributes of the station are displayed.
5. The following station attributes pertain to ADF, VOR, FM, and TACAN facilities:

   - Station Identifier
   - Frequency
   - Station Latitude
   - Station Longitude
   - Elevation
   - Range

6. The following station attributes pertain to ILS facilities:

   - Station Identifier
   - Frequency
   - Station Latitude
   - Station Longitude
   - Elevation
   - Range

- Outer Marker Latitude
- Outer Marker Longitude
- Middle Marker Latitude
- Middle Marker Longitude
- Runway Length
- Runway Heading
- Glidescope Angle
- Backcourse Available

7. The following station attributes pertain to GCA facilities:

- Station Identifier
- Station Latitude
- Station Longitude
- Elevation
- Runway Length
- Runway Heading
- Glidescope Angle
- Decision Height

INTERFACES

1. Navigational Facilities are read from a data base.
2. Navaids can be enabled and disabled at the AID Control Panel.
3. The Facility Identifier is entered on the Numeric Keypad.
4. Updated Navaid Lists are sent to the Trainee Station CSC.
5. The Navaids for the cockpit entered on the Numeric Keypad are displayed in the edit area of the AID when the EDIT AREA and RADIO NAV push buttons on the AID Controls are depressed.
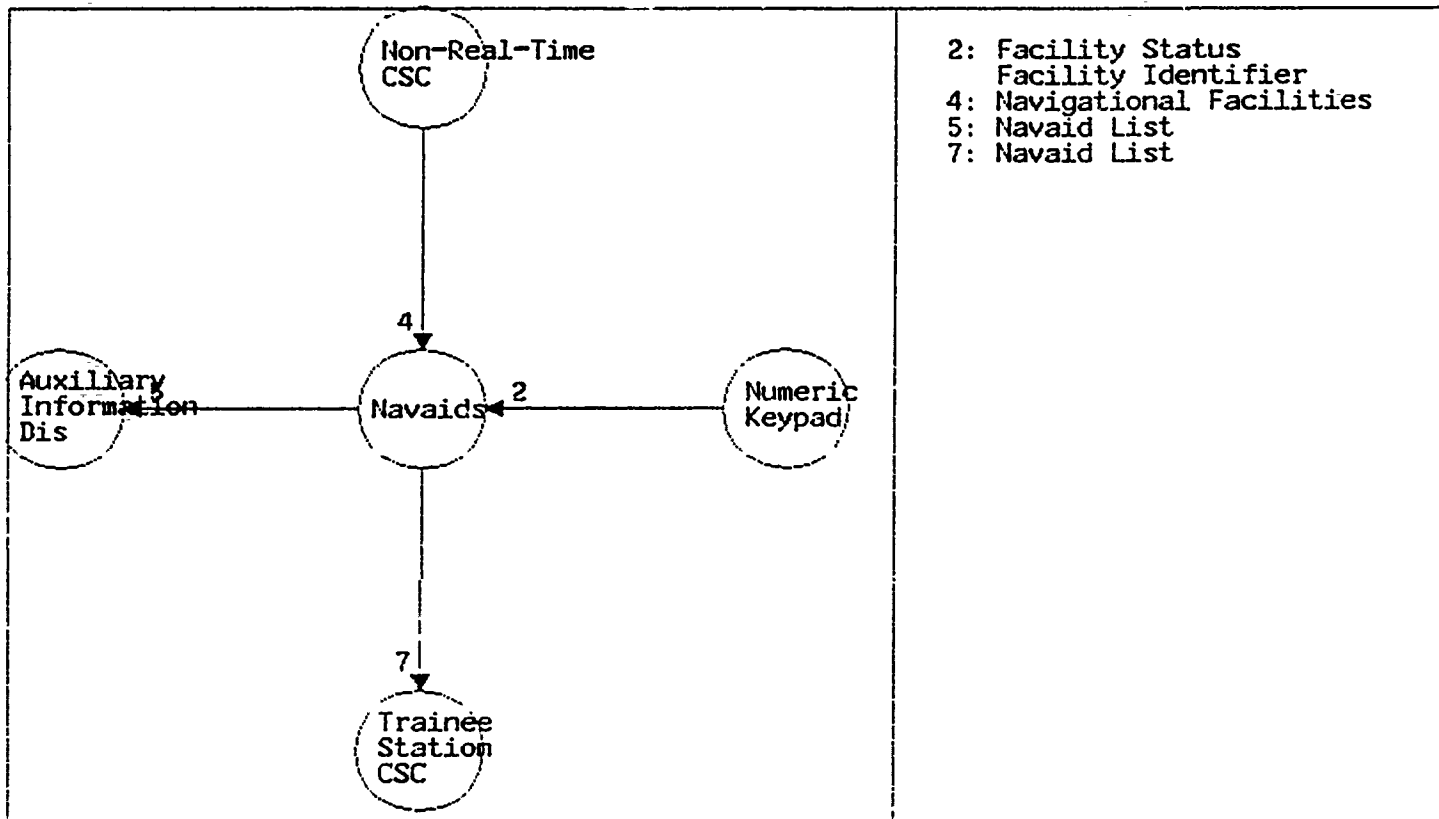
Figure 3-48. Navaids CID.

3.2.3 FLIGHT HISTORY

This subsystem includes those classes that record the simulated flight for possible replay.

CLASSES

1. Playback Information
2. Stored Plots

3.2.3.1 Playback Information

The Playback Information is a record of the last five minutes of operation of the Motion System. It is used when the trainee or instructor operator wants to replay a portion of a training session. The Playback Information class is depicted in Figure 49.

ATTRIBUTES

1. Altitude History
2. Air Speed History
3. Heading History
4. Roll History
5. Pitch History
6. Yaw History
7. Vertical Velocity History
8. Rate of Turn History
9. Torque Pressure History
10. Rotor RPM History
11. Latitude History
12. Longitude History
13. Fuel Weight History
14. Center of Gravity History
15. Gross Weight History
16. Barometric Pressure History
17. Outside Air Temperature History
18. Wind Velocity History
19. Wind Direction History
20. Turbulence Level History
21. Sound Level History
22. Static Level History
23. Auxiliary Power Unit History
24. Rate of Fuel Burn History

IMPORTED DATA

1. Altitude
2. Air Speed
3. Heading
4. Roll
5. Pitch
6. Yaw
7. Vertical Velocity
8. Rate of Turn
9. Torque Pressure
10. Rotor RPM
11. Latitude
12. Longitude
13. Fuel Weight
14. Center of Gravity
15. Gross Weight
16. Barometric Pressure

17. Outside Air Temperature
18. Wind Velocity
19. Wind Direction
20. Turbulence Level
21. Sound Level
22. Static Level
23. Auxiliary Power Unit
24. Rate of Fuel Burn
25. Minutes

EXPORTED DATA

1. Altitude
2. Air Speed
3. Heading
4. Roll
5. Pitch
6. Yaw
7. Vertical Velocity
8. Rate of Turn
9. Torque Pressure
10. Rotor RPM
11. Latitude
12. Longitude
13. Fuel Weight
14. Center of Gravity
15. Gross Weight
16. Barometric Pressure
17. Outside Air Temperature
18. Wind Velocity
19. Wind Direction
20. Turbulence Level
21. Sound Level
22. Static Level
23. Auxiliary Power Unit
24. Rate of Fuel Burn

PROCESSING

1. Playback replays the stored history of the simulated flight.
2. Up to five minutes of information is stored.
3. Playback is run in segments of 1, 2, 3, 4, or 5 minutes.
4. After playback has been set to a specified number of minutes, playback must be explicitly started.
5. Playback may only take place if the trainer is frozen.
6. Both trainer motion and audio are replayed.
7. Playback may also be run in slow-time at 50% normal speed.
8. Audio is not replayed in slow-time.

INTERFACES

1. Playback stores the history of the Flight Parameters.
2. When run, Playback sends the stored values back to the Flight Parameters.

3. Playback is set to the number of minutes coresponding to the value of the MIN SEL thumbwheel switch when the RESET push button on the Playback Controls is depressed.
4. Playback is stopped when the PAUSE push button on the Playback Controls is depressed while playback is in progress.
5. Playback is restarted when the PAUSE push button on the Playback Controls is depressed while playback is not in progress.
6. Playback is run in slow-time when the SLOW TIME push button on the Playback Controls is depressed while playback is running at normal speed.
7. Playback is reset to normal speed when the SLOW TIME push button on the Playback Controls is depressed while playback is running in slow-time.

Flight
Parameters

1

2

Playback
Information

4

Playback
Controls

1: Yaw
   Wind Velocity
   Wind Direction
   Vertical Velocity
   Turbulence Level
   Torque Pressure
   Static Level
   Sound Level
   Rotor RPM
   Roll
   Rate of Turn
   Rate of Fuel Burn
   Pitch
   Outside Air Temperature
   Longitude
   Latitude
   Heading
   Gross Weight
   Fuel Weight
   Center of Gravity
   Barometric Pressure
   Auxiliary Power Unit
   Altitude
   Air Speed
2: Yaw
   Wind Velocity
   Wind Direction
   Vertical Velocity
   Turbulence Level
   Torque Pressure

   Static Level
   Sound Level
   Rotor RPM
   Roll
   Rate of Turn
   Rate of Fuel Burn
   Pitch
   Outside Air Temperature
   Longitude
   Latitude
   Heading
   Gross Weight
   Fuel Weight
   Center of Gravity
   Barometric Pressure
   Auxiliary Power Unit
   Altitude
   Air Speed
4: Minutes

Figure 3-49. Playback Information CID.

3.2.3.2 Stored Plots

The Stored Plots are a record of the ground track, the air speed, and the altitude for fifteen minutes of flight ending at a specified time. They are used when the trainee or instructor operator wants to display the ground track from any 15 minute portion of the session. The Stored Plots class is depicted in Figure 50.

ATTRIBUTES

    1. Air Speed Plots
    2. Altitude Plots
    3. Latitude Plots
    4. Longitude Plots

IMPORTED DATA

    1. Air Speed
    2. Altitude
    3. Latitude
    4. Longitude
    5. Cockpit
    6. Duration

EXPORTED DATA

    1. Air Speed
    2. Altitude
    3. Latitude
    4. Longitude
    5. Stored Plot List

PROCESSING

    1. A continuous history of Air Speed, Altitude, Latitude and Longitude for a session is maintained.
    2. Display period begins fifteen minutes prior to time specified, or at the beginning of the session if it has been less than fifteen minutes.
    3. Playback does not affect the motion of the trainer.

INTERFACES

    1. Stored Plots are edited at the AID Control Panel.
    2. The Cockpit and the Duration are entered on the Numeric Keypad.
    3. Stored Plots cause a replay of the following:

        • a Cross Country Map of the entire gaming area
        • a Ground Track
        • any Visual Error Alerts
        • the default map scale in the Problem Status Display

    4. The Stored Plots for the selected Cockpit are displayed in the edit area of the AID when the EDIT AREA and STORD PLOTS push buttons on the AID Controls are depressed.
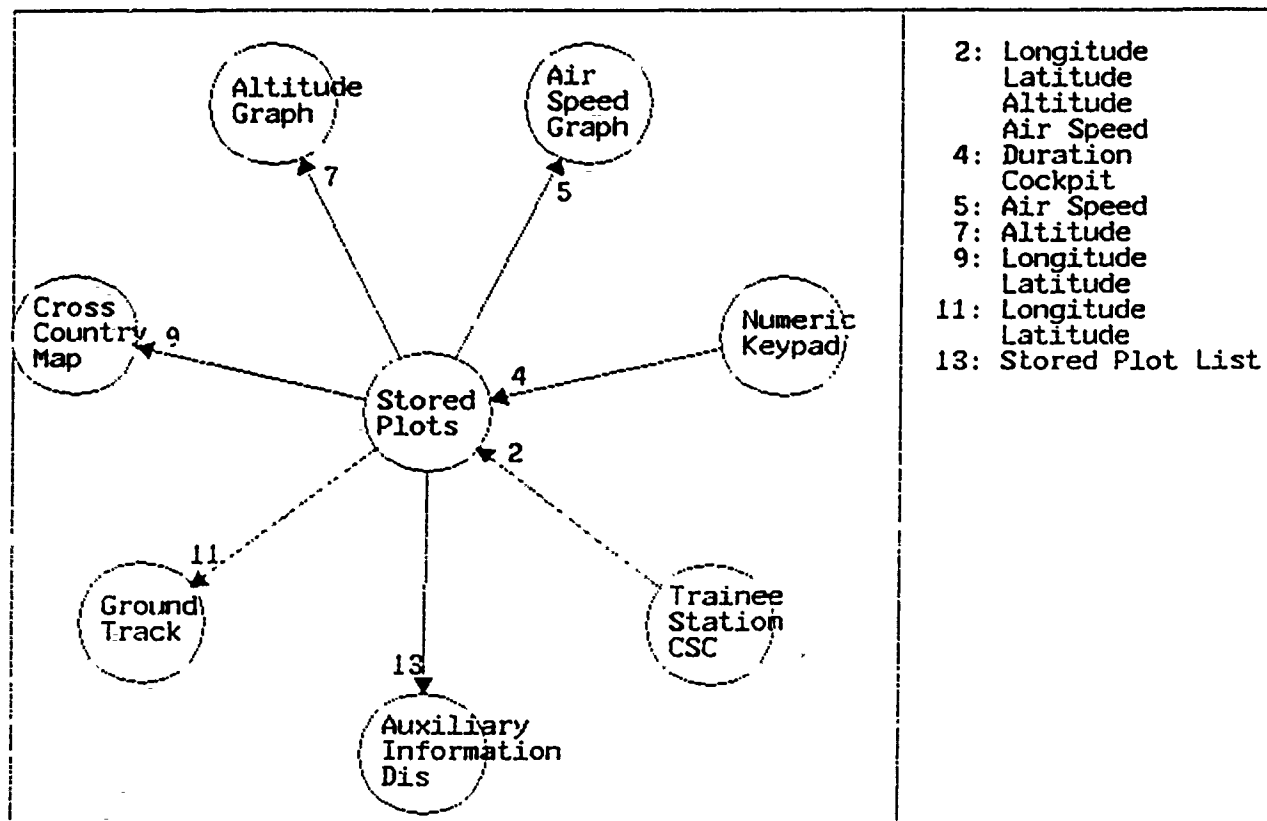
Figure 3-50. Stored Plots CID.

3.3 CSCI INTERNAL INTERFACES

This section discusses the relations between the major subsystems of the UH-1 Helicopter Flight Simulator. These are the following:

- Input/Output Devices
- Flight Monitor
- Editable Displays
- Trainee Station CSC
- Non-Real-Time CSC

The Input and Output Devices are the software entities that interface with the s, .em hardware. The Flight Monitor is the mechanism by which the IOS controls and monitors the Trainee Station. The Editable Displays represent the shared data between the IOS and the Trainee Station. The Trainee Station CSC constitutes the simulated portion of the system.

INTERNAL INTERFACES

	Data	Source Class	Destination Class
1.	Cockpit	Cockpit Display Select Controls	Problem Status Display
2.	Mode of Operation	Mode Controls	Problem Status Display
3.	Radio Call Number	Trainee Station CSC	Problem Status Display
4.	Exercise in Progress	Trainee Station CSC	Problem Status Display
5.	VHFC Frequency	Trainee Station CSC	Problem Status Display
6.	UHF Frequency	Trainee Station CSC	Problem Status Display
7.	FM Frequency	Trainee Station CSC	Problem Status Display
8.	VHFN Frequency	Trainee Station CSC	Problem Status Display
9.	ADF Frequency	Trainee Station CSC	Problem Status Display
10.	Transponder Mode	Trainee Station CSC	Problem Status Display
11.	Partial Panel	Trainee Station CSC	Problem Status Display
12.	Auto Copilot	Trainee Station CSC	Problem Status Display
13.	Ground Communication in Progress	Trainee Station CSC	Problem Status Display
14.	Weight on Skids	Trainee Station CSC	Problem Status Display
15.	Trainer Ready	Trainee Station CSC	Problem Status Display
16.	Assistance Requested	Trainee Station CSC	Problem Status Display
17.	Slow Time	Trainee Station CSC	Problem Status Display
18.	Real Time	Trainee Station CSC	Problem Status Display
19.	Twenty Minute Fuel Remaining Indication	Trainee Station CSC	Problem Status Display
20.	Freeze/Crash	Trainee Station CSC	Problem Status Display
21.	Cross Country Map Scale	Graphic Display Controls	Problem Status Display
22.	GCA Graph Scale	Graphic Display Controls	Problem Status Display
23.	Altitude Frozen	Flight Parameters	Problem Status Display
24.	Air Speed Frozen	Flight Parameters	Problem Status Display
25.	Heading Frozen	Flight Parameters	Problem Status Display
26.	Roll Frozen	Flight Parameters	Problem Status Display
27.	Pitch Frozen	Flight Parameters	Problem Status Display
28.	Yaw Frozen	Flight Parameters	Problem Status Display
29.	Vertical Velocity Frozen	Flight Parameters	Problem Status Display

30.	Rate of Turn Frozen	Flight Parameters	Problem Status Display
31.	Torque Pressure Frozen	Flight Parameters	Problem Status Display
32.	Rotor RPM Frozen	Flight Parameters	Problem Status Display
33.	Wind Direction	Flight Parameters	Problem Status Display
34.	Wind Velocity	Flight Parameters	Problem Status Display
35.	Turbulence Level	Flight Parameters	Problem Status Display
36.	Malfunction List	Malfunction Lists	Problem Status Display
37.	Problem Status Display	Problem Status Display	Cockpit CRT
38.	Cockpit	Cockpit Display Select Controls	Air Speed Graph
39.	Air Speed	Trainee Station CSC	Air Speed Graph
40.	Air Speed Graph	Air Speed Graph	Cockpit CRT
41.	Cockpit	Cockpit Display Select Controls	Altitude Graph
42.	Altitude	Trainee Station CSC	Altitude Graph
43.	Altitude Graph	Altitude Graph	Cockpit CRT
44.	Cockpit	Cockpit Display Select Controls	Cross Country Map
45.	Cockpit	Numeric Keypad	Cross Country Map
46.	Cross Country Map Scale	Graphic Display Controls	Cross Country Map
47.	Navigational Facilities	Non-Real-Time CSC	Cross Country Map
48.	Latitude	Trainee Station CSC	Cross Country Map
49.	Longitude	Trainee Station CSC	Cross Country Map
50.	Cross Country Map	Cross Country Map	Cockpit CRT
51.	Cross Country Map	Cross Country Map	Auxiliary Information Display
52.	Approach Map Area	Graphic Display Controls	Approach Map
53.	Approach Map Area	Numeric Keypad	Approach Map
54.	Navigational Facilities	Non-Real-Time CSC	Approach Map
55.	Approach Map	Approach Map	Cockpit CRT
56.	Approach Map	Approach Map	Auxiliary Information Display
57.	Cockpit	Cockpit Display Select Controls	GCA Graph
58.	Cockpit	Numeric Keypad	GCA Graph
59.	GCA Graph Scale	Graphic Display Controls	GCA Graph
60.	Altitude	Trainee Station CSC	GCA Graph
61.	Latitude	Trainee Station CSC	GCA Graph
62.	Longitude	Trainee Station CSC	GCA Graph
63.	Range	Trainee Station CSC	GCA Graph
64.	GCA Graph	GCA Graph	Cockpit CRT
65.	GCA Graph	GCA Graph	Auxiliary Information Display
66.	Cockpit	Cockpit Display Select Controls	Ground Track
67.	Cockpit	Numeric Keypad	Ground Track
68.	Cross Country Map Scale	Graphic Display Controls	Ground Track
69.	Latitude	Trainee Station CSC	Ground Track
70.	Longitude	Trainee Station CSC	Ground Track
71.	Ground Track	Ground Track	Cockpit CRT
72.	Ground Track	Ground Track	Auxiliary Information Display
73.	Cockpit	Cockpit Display Select Controls	Visual Error Alerts
74.	Cockpit	Numeric Keypad	Visual Error Alerts

75.	Error	Trainee Station CSC	Visual Error Alerts
76.	Visual Error Alerts	Visual Error Alerts	Cockpit CRT
77.	Visual Error Alerts	Visual Error Alerts	Auxiliary Information Display
78.	Cockpit	Cockpit Display Select Controls	GCA Information
79.	Cockpit	Numeric Keypad	GCA Information
80.	Radio Call Number	Trainee Station CSC	GCA Information
81.	Heading	Trainee Station CSC	GCA Information
82.	Range	Trainee Station CSC	GCA Information
83.	Altitude	Trainee Station CSC	GCA Information
84.	Latitude	Trainee Station CSC	GCA Information
85.	Longitude	Trainee Station CSC	GCA Information
86.	GCA Information	GCA Information	Cockpit CRT
87.	GCA Information	GCA Information	Auxiliary Information Display
88.	Cockpit	AID Controls	Initial Condition Sets
89.	Cockpit	Numeric Keypad	Initial Condition Sets
90.	Initial Condition Set Identifier	Numeric Keypad	Initial Condition Sets
91.	Initial Condition Setups	Non-Real-Time CSC	Initial Condition Sets
92.	Altitude	Numeric Keypad	Initial Condition Sets
93.	Air Speed	Numeric Keypad	Initial Condition Sets
94.	Heading	Numeric Keypad	Initial Condition Sets
95.	Roll	Numeric Keypad	Initial Condition Sets
96.	Pitch	Numeric Keypad	Initial Condition Sets
97.	Yaw	Numeric Keypad	Initial Condition Sets
98.	Vertical Velocity	Numeric Keypad	Initial Condition Sets
99.	Rate of Turn	Numeric Keypad	Initial Condition Sets
100.	Torque Pressure	Numeric Keypad	Initial Condition Sets
101.	Rotor RPM	Numeric Keypad	Initial Condition Sets
102.	Latitude	Numeric Keypad	Initial Condition Sets
103.	Longitude	Numeric Keypad	Initial Condition Sets
104.	Fuel Weight	Numeric Keypad	Initial Condition Sets
105.	Center of Gravity	Numeric Keypad	Initial Condition Sets
106.	Gross Weight	Numeric Keypad	Initial Condition Sets
107.	Barometric Pressure	Numeric Keypad	Initial Condition Sets
108.	Outside Air Temperature	Numeric Keypad	Initial Condition Sets
109.	Wind Velocity	Numeric Keypad	Initial Condition Sets
110.	Wind Direction	Numeric Keypad	Initial Condition Sets
111.	Turbulence Level	Numeric Keypad	Initial Condition Sets
112.	Sound Level	Numeric Keypad	Initial Condition Sets
113.	Static Level	Numeric Keypad	Initial Condition Sets
114.	Auxiliary Power Unit	Numeric Keypad	Initial Condition Sets
115.	Rate of Fuel Burn	Numeric Keypad	Initial Condition Sets
116.	Initial Condition Set	Initial Condition Sets	Auxiliary Information Display
117.	Initial Condition Set	Initial Condition Sets	Trainee Station CSC
118.	Cockpit	AID Controls	Flight Parameters
119.	Cockpit	Numeric Keypad	Flight Parameters
120.	Flight Parameter Identifier	Numeric Keypad	Flight Parameters
121.	Altitude	Trainee Station CSC	Flight Parameters
122.	Air Speed	Trainee Station CSC	Flight Parameters

123.	Heading	Trainee Station CSC	Flight Parameters
124.	Roll	Trainee Station CSC	Flight Parameters
125.	Pitch	Trainee Station CSC	Flight Parameters
126.	Yaw	Trainee Station CSC	Flight Parameters
127.	Vertical Velocity	Trainee Station CSC	Flight Parameters
128.	Rate of Turn	Trainee Station CSC	Flight Parameters
129.	Torque Pressure	Trainee Station CSC	Flight Parameters
130.	Rotor RPM	Trainee Station CSC	Flight Parameters
131.	Latitude	Trainee Station CSC	Flight Parameters
132.	Longitude	Trainee Station CSC	Flight Parameters
133.	Fuel Weight	Trainee Station CSC	Flight Parameters
134.	Center of Gravity	Trainee Station CSC	Flight Parameters
135.	Gross Weight	Trainee Station CSC	Flight Parameters
136.	Barometric Pressure	Trainee Station CSC	Flight Parameters
137.	Outside Air Temperature	Trainee Station CSC	Flight Parameters
138.	Wind Velocity	Trainee Station CSC	Flight Parameters
139.	Wind Direction	Trainee Station CSC	Flight Parameters
140.	Turbulence Level	Trainee Station CSC	Flight Parameters
141.	Sound Level	Trainee Station CSC	Flight Parameters
142.	Static Level	Trainee Station CSC	Flight Parameters
143.	Auxiliary Power Unit	Trainee Station CSC	Flight Parameters
144.	Rate of Fuel Burn	Trainee Station CSC	Flight Parameters
145.	Altitude	Numeric Keypad	Flight Parameters
146.	Air Speed	Numeric Keypad	Flight Parameters
147.	Heading	Numeric Keypad	Flight Parameters
148.	Roll	Numeric Keypad	Flight Parameters
149.	Pitch	Numeric Keypad	Flight Parameters
150.	Yaw	Numeric Keypad	Flight Parameters
151.	Vertical Velocity	Numeric Keypad	Flight Parameters
152.	Rate of Turn	Numeric Keypad	Flight Parameters
153.	Torque Pressure	Numeric Keypad	Flight Parameters
154.	Rotor RPM	Numeric Keypad	Flight Parameters
155.	Latitude	Numeric Keypad	Flight Parameters
156.	Longitude	Numeric Keypad	Flight Parameters
157.	Fuel Weight	Numeric Keypad	Flight Parameters
158.	Center of Gravity	Numeric Keypad	Flight Parameters
159.	Gross Weight	Numeric Keypad	Flight Parameters
160.	Barometric Pressure	Numeric Keypad	Flight Parameters
161.	Outside Air Temperature	Numeric Keypad	Flight Parameters
162.	Wind Velocity	Numeric Keypad	Flight Parameters
163.	Wind Direction	Numeric Keypad	Flight Parameters
164.	Turbulence Level	Numeric Keypad	Flight Parameters
165.	Sound Level	Numeric Keypad	Flight Parameters
166.	Static Level	Numeric Keypad	Flight Parameters
167.	Auxiliary Power Unit	Numeric Keypad	Flight Parameters
168.	Rate of Fuel Burn	Numeric Keypad	Flight Parameters
169.	Turbulence Level	Problem Controls	Flight Parameters
170.	Flight Parameter List	Flight Parameters	Auxiliary Information Display
171.	Flight Parameter List	Flight Parameters	Trainee Station CSC
172.	Cockpit	AID Controls	Malfunction Lists
173.	Cockpit	Numeric Keypad	Malfunction Lists

174.	Malfunction Identifier	Malfunction Controls	Malfunction Lists
175.	Malfunction Identifier	Problem Controls	Malfunction Lists
176.	Malfunction Identifier	Numeric Keypad	Malfunction Lists
177.	Malfunctions	Non-Real-Time CSC	Malfunction Lists
178.	Malfunction Status	Numeric Keypad	Malfunction Lists
179.	Time of Enablement	Numeric Keypad	Malfunction Lists
180.	Malfunction List	Malfunction Lists	Auxiliary Information Display
181.	Malfunction List	Malfunction Lists	Trainee Station CSC
182.	Facility Identifier	Numeric Keypad	Navaids
183.	Navigational Facilities	Non-Real-Time CSC	Navaids
184.	Facility Status	Numeric Keypad	Navaids
185.	Navaid List	Navaids	Auxiliary Information Display
186.	Navaid List	Navaids	Trainee Station CSC
187.	Altitude	Flight Parameters	Playback Information
188.	Air Speed	Flight Parameters	Playback Information
189.	Heading	Flight Parameters	Playback Information
190.	Roll	Flight Parameters	Playback Information
191.	Pitch	Flight Parameters	Playback Information
192.	Yaw	Flight Parameters	Playback Information
193.	Vertical Velocity	Flight Parameters	Playback Information
194.	Rate of Turn	Flight Parameters	Playback Information
195.	Torque Pressure	Flight Parameters	Playback Information
196.	Rotor RPM	Flight Parameters	Playback Information
197.	Latitude	Flight Parameters	Playback Information
198.	Longitude	Flight Parameters	Playback Information
199.	Fuel Weight	Flight Parameters	Playback Information
200.	Center of Gravity	Flight Parameters	Playback Information
201.	Gross Weight	Flight Parameters	Playback Information
202.	Barometric Pressure	Flight Parameters	Playback Information
203.	Outside Air Temperature	Flight Parameters	Playback Information
204.	Wind Velocity	Flight Parameters	Playback Information
205.	Wind Direction	Flight Parameters	Playback Information
206.	Turbulence Level	Flight Parameters	Playback Information
207.	Sound Level	Flight Parameters	Playback Information
208.	Static Level	Flight Parameters	Playback Information
209.	Auxiliary Power Unit	Flight Parameters	Playback Information
210.	Rate of Fuel Burn	Flight Parameters	Playback Information
211.	Minutes	Playback Controls	Playback Information
212.	Altitude	Playback Information	Flight Parameters
213.	Air Speed	Playback Information	Flight Parameters
214.	Heading	Playback Information	Flight Parameters
215.	Roll	Playback Information	Flight Parameters
216.	Pitch	Playback Information	Flight Parameters
217.	Yaw	Playback Information	Flight Parameters
218.	Vertical Velocity	Playback Information	Flight Parameters
219.	Rate of Turn	Playback Information	Flight Parameters
220.	Torque Pressure	Playback Information	Flight Parameters
221.	Rotor RPM	Playback Information	Flight Parameters
222.	Latitude	Playback Information	Flight Parameters
223.	Longitude	Playback Information	Flight Parameters

224.	Fuel Weight	Playback Information	Flight Parameters
225.	Center of Gravity	Playback Information	Flight Parameters
226.	Gross Weight	Playback Information	Flight Parameters
227.	Barometric Pressure	Playback Information	Flight Parameters
228.	Outside Air Temperature	Playback Information	Flight Parameters
229.	Wind Velocity	Playback Information	Flight Parameters
230.	Wind Direction	Playback Information	Flight Parameters
231.	Turbulence Level	Playback Information	Flight Parameters
232.	Sound Level	Playback Information	Flight Parameters
233.	Static Level	Playback Information	Flight Parameters
234.	Auxiliary Power Unit	Playback Information	Flight Parameters
235.	Rate of Fuel Burn	Playback Information	Flight Parameters
236.	Air Speed	Trainee Station CSC	Stored Plots
237.	Altitude	Trainee Station CSC	Stored Plots
238.	Latitude	Trainee Station CSC	Stored Plots
239.	Longitude	Trainee Station CSC	Stored Plots
240.	Cockpit	Numeric Keypad	Stored Plots
241.	Duration	Numeric Keypad	Stored Plots
242.	Air Speed	Stored Plots	Air Speed Graph
243.	Altitude	Stored Plots	Altitude Graph
244.	Latitude	Stored Plots	Cross Country Map
245.	Longitude	Stored Plots	Cross Country Map
246.	Latitude	Stored Plots	Ground Track
247.	Longitude	Stored Plots	Ground Track
248.	Stored Plot List	Stored Plots	Auxiliary Information Display
249.	Instructor Call	Flight Controls	Problem Controls
250.	Instructor Call	Problem Controls	Flight Controls
251.	Channel	Communication Controls	Trainee Station CSC
252.	Cockpit	Cockpit Display Select Controls	Cockpit Select Controls

3.4 CSCI DATA ELEMENT REQUIREMENTS

DATA ELEMENTS

	Attribute	Unit of Measure/Value
1.	ADF Frequency	Kilohertz
2.	Air Speed	Feet per second
3.	Air Speed Graph	1 x 10 inches
4.	Air Speed Frozen	False/True
5.	Air Speed History	5 Minutes of Feet per second
6.	Air Speed Plots	15 Minutes of Feet per second
7.	Altitude	Feet
8.	Altitude Graph	1 x 10 inches
9.	Altitude Frozen	False/True
10.	Altitude History	5 Minutes of Feet
11.	Altitude Plots	15 Minutes of Feet
12.	Approach Map	10 x 10 inches/12 x 12 inches
13.	Approach Map Area	1 .. 9
14.	Assistance Requested	False/True
15.	Auto Copilot	Off/On
16.	Auxiliary Power Unit	False/True
17.	Auxiliary Power Unit History	5 Minutes of False/True
18.	Barometric Pressure	Inches of mercury
19.	Barometric Pressure History	5 Minutes of Inches of mercury
20.	Center of Gravity	Inches
21.	Center of Gravity History	5 minutes of Inches
22.	Channel	UHF/VHF/FM/VHF NAV/ICS
23.	Cockpit	1 .. 4
24.	Course Deviation	Degrees
25.	Cross Country Map	10 x 10 inches/12 x 12 inches
26.	Cross Country Map Scale	12.5/25/100
27.	Duration	1 .. 15
28.	Elapsed Time	Mintues
29.	Error	Course Deviation/Glide Slope Deviation/Altitude/Air Speed/Heading/Roll/Pitch/Yaw/Vertical Velocity/Rate of Turn/Torque Pressure
30.	Exercise in Progress	False/True
31.	Facility Identifier	1 .. n
32.	Facility Status	Enabled/Disabled
33.	Facility Status List	1 .. n of Enabled/Disabled
34.	Flight Parameter Identifier	1 .. 24
35.	Flight Parameter List	Altitude, Air Speed, Heading, Roll, Pitch, Yaw, Vertical Velocity, Rate of Turn, Torque Pressure, Rotor RPM, Latitude, Longitude, Fuel Weight, Center of Gravity, Gross Weight, Barometric Pressure, Outside Air Temperature, Wind Velocity, Wind Direction, Turbulence Level, Sound Level, Static Level, Auxiliary Power Unit, Rate of Fuel Burn
36.	FM Frequeny	Megahertz
37.	Freeze/Crash	Off/On

38.	Fuel Weight	Pounds
39.	Fuel Weight History	5 Minutes of Pounds
40.	GCA Graph	7.5 x 10 inches/9 x 12 inches
41.	GCA Graph Scale	2.5/10
42.	GCA Information	2.5 x 10 inches/3 x 12 inches
43.	Glide Path Deviation	Degrees
44.	Gross Weight	Pounds
45.	Gross Weight History	5 Minutes of Pounds
46.	Ground Communication in Progress	False/True
47.	Ground Track	10 x 10 inches/12 x 12 inches
48.	Heading	Degrees
49.	Heading Frozen	False/True
50.	Heading History	5 Minutes of Degrees
51.	Initial Condition Set	Altitude, Air Speed, Heading, Roll, Pitch, Yaw, Vertical Velocity, Rate of Turn, Torque Pressure, Rotor RPM, Latitude, Longitude, Fuel Weight, Center of Gravity, Gross Weight, Barometric Pressure, Outside Air Temperature, Wind Velocity, Wind Direction, Turbulence Level, Sound Level, Static Level, Auxiliary Power Unit, Rate of Fuel Burn
52.	Initial Condition Set Identifier	1 .. 20
53.	Initial Condition Setups	1 .. 20 of Altitude, Air Speed, Heading, Roll, Pitch, Yaw, Vertical Velocity, Rate of Turn, Torque Pressure, Rotor RPM, Latitude, Longitude, Fuel Weight, Center of Gravity, Gross Weight, Barometric Pressure, Outside Air Temperature, Wind Velocity, Wind Direction, Turbulence Level, Sound Level, Static Level, Auxiliary Power Unit, Rate of Fuel Burn
54.	Instructor Call	Initiated/Acknowledged
55.	Last Frequency on Which Aircraft Transmitted	Hertz
56.	Latitude	Degrees
57.	Latitude History	5 Minutes of Degrees
58.	Latitude Plots	15 Minutes of Degrees
59.	Longitude	Degrees
60.	Longitude History	5 Minutes of Degrees
61.	Longitude Plots	15 Minutes of Degrees
62.	Malfunction Identifier	0 .. 9
63.	Malfunction Identifier List	1 .. 10 of 1 .. 107
64.	Malfunction List	1 .. 10 of 1 .. 107, Enabled/Disabled, Minutes
65.	Malfunction Status	Enabled/Disabled
66.	Malfunction Status List	1 .. 10 of Enabled/Disabled
67.	Malfunctions	1 .. 107
68.	Map Scale	2.5/10/12.5/25/100
69.	Minutes	1 .. 5
70.	Mode of Operation	Off/Semiautomatic
71.	Navaid List	1 .. n of Enabled/Disabled
72.	Navigational Facilities	1 .. n of Station Identifier, Frequency, Station Latitude, Station Longitude, Elevation, Range, Outer Marker Latitude, Outer Marker Longitude, Middle Marker Latitude, Middle Marker Longitude, Runway Length,

		Runway Heading, Glidescope Angle, Backcourse Available, Decision Height
73.	Outside Air Temperature	Degrees Celsius
74.	Outside Air Temperature History	5 Minutes of Degrees Celsius
75.	Partial Panel	Off/On
76.	Pitch	Degrees
77.	Pitch Frozen	False/True
78.	Pitch History	5 Minutes of Degrees
79.	Problem Status Display	12 x 2 inches
80.	Radio Call Number	1 .. 2 of 'A' .. 'Z', 3 .. 6 of '0 .. '9'
81.	Range	Nautical Miles
82.	Rate of Fuel Burn	Pounds per hour
83.	Rate of Fuel Burn History	5 Minutes of Pounds per hour
84.	Rate of Turn	Radians per second
85.	Rate of Turn Frozen	False/True
86.	Rate of Turn History	5 Minutes of Radians per second
87.	Real Time	Off/On
88.	Roll	Degrees
89.	Roll Frozen	False/True
90.	Roll History	5 Minutes of Degrees
91.	Rotor RPM	Revolutions per minute
92.	Rotor RPM Frozen	False/True
93.	Rotor RPM History	5 Minutes of Revolutions per minute
94.	Slow Time	Off/On
95.	Sound Level	0 .. 9
96.	Sound Level History	5 Minutes of 0 .. 9
97.	Static Level	0 .. 9
98.	Static Level History	5 Minutes of 0 .. 9
99.	Stored Plot List	1 .. 4, 1 .. 15
100.	Time of Enablement	Minutes
101.	Time of Enablement List	1 .. 10 of Minutes
102.	Torque Pressure	Pounds per square inch
103.	Torque Pressure Frozen	False/True
104.	Torque Pressure History	5 Minutes of Pounds per square inch
105.	Trainer Ready	False/True
106.	Transponder Mode	Off/Standby/Low/Normal/Emergency
107.	Turbulence Level	0 .. 9
108.	Turbulence Level History	5 Minutes of 0 .. 9
109.	Twenty Minute Fuel Remaining Indication	Off/On
110.	UHF Frequency	Megahertz
111.	Vertical Velocity	Feet per second
112.	Vertical Velocity Frozen	False/True
113.	Vertical Velocity History	5 Minutes of Feet per second
114.	VHFC Frequency	Megahertz
115.	VHFN Frequency	Megahertz
116.	Visual Error Alerts	10 x 10 inches/12 x 12 inches
117.	Weight on Skids	False/True
118.	Wind Direction	Degrees
119.	Wind Direction History	5 Minutes of Degrees
120.	Wind Velocity	Knots
121.	Wind Velocity History	5 Minutes of Knots

122.	Yaw	Degrees
123.	Yaw Frozen	False/True
124.	Yaw History	5 Minutes of Degrees
125.	Air Speed Graph Area State	1 x 10 inches
126.	Altitude Graph Area State	1 x 10 inches
127.	Cockpit #1 Display Area State	6 x 3 inches
128.	Cockpit #2 Display Area State	6 x 3 inches
129.	Cockpit #3 Display Area State	6 x 3 inches
130.	Cockpit #4 Display Area State	6 x 3 inches
131.	Cockpit #1 Edit Area State	6 x 3 inches
132.	Cockpit #2 Edit Area State	6 x 3 inches
133.	Cockpit #3 Edit Area State	6 x 3 inches
134.	Cockpit #4 Edit Area State	6 x 3 inches
135.	Control Sequence	Null/0/1/2/3/4/5/6/7/8/9/./-/Clear/Enter/Tab
136.	Map Plot Area State	10 x 10 inches
137.	Problem Status Area State	12 x 2 inches
138.	1 State (AID)	On, Illuminated/Off, Extinguished
139.	2 State (AID)	On, Illuminated/Off, Extinguished
140.	3 State (AID)	On, Illuminated/Off, Extinguished
141.	4 State (AID)	On, Illuminated/Off, Extinguished
142.	1 State (Cockpit Display Select)	On, Illuminated/Off, Extinguished
143.	2 State (Cockpit Display Select)	On, Illuminated/Off, Extinguished
144.	3 State (Cockpit Display Select)	On, Illuminated/Off, Extinguished
145.	4 State (Cockpit Display Select)	On, Illuminated/Off, Extinguished
146.	1 State (Cockpit Select)	Illuminated/Extinguished
147.	2 State (Cockpit Select)	Illuminated/Extinguished
148.	3 State (Cockpit Select)	Illuminated/Extinguished
149.	4 State (Cockpit Select)	Illuminated/Extinguished
150.	ACK STUD State	On, Flashing/Off, Extinguished
151.	AREA SEL Value	0 .. 9
152.	AREA State	On, Illuminated/Off, Extinguished
153.	ATC State	On, Illuminated/Off, Extinguished
154.	AUTO COPILOT State (Flight)	On, Illuminated/Off, Extinguished
155.	AUTO COPILOT State (Problem)	On, Illuminated/Off, Extinguished
156.	CKPT 1 AREA State	On, Illuminated/Off, Extinguished
157.	CKPT 2 AREA State	On, Illuminated/Off, Extinguished
158.	CKPT 3 AREA State	On, Illuminated/Off, Extinguished
159.	CKPT 4 AREA State	On, Illuminated/Off, Extinguished
160.	COMM AUDIO NET State	On, Illuminated/Off, Extinguished
161.	CONT State	On, Illuminated/Off, Extinguished
162.	CRASH OVRD State	On, Illuminated/Off, Extinguished
163.	CROSS CNTRY State	On, Illuminated/Off, Extinguished
164.	DEMO Value	0 .. 9
165.	EDIT AREA State	On, Illuminated/Off, Extinguished
166.	FAIL State	On, Illuminated/Off, Extinguished
167.	FLT PRMTR FRZ State	On, Illuminated/Off, Extinguished
168.	FLT PRMTR RSTRE State	On, Illuminated/Off, Extinguished
169.	FLT PRMTR State	On, Illuminated/Off, Extinguished
170.	FRZ State	On, Illuminated/Off, Extinguished
171.	FULL SCALE ALT State	On, Illuminated/Off, Extinguished

172.	FULL SCALE AS State	On, Illuminated/Off, Extinguished
173.	GCA COMM State	On, Illuminated/Off, Extinguished
174.	GCA State	On, Illuminated/Off, Extinguished
175.	GND TRK ERASE State	On, Illuminated/Off, Extinguished
176.	GTRK 12.5 X 12.5 State	On, Illuminated/Off, Extinguished
177.	GTRK 25 X 25 State	On, Illuminated/Off, Extinguished
178.	GTRK 100 X 100 State	On, Illuminated/Off, Extinguished
179.	ICS State	On, Illuminated/Off, Extinguished
180.	IN PROG State (Playback)	Illuminated/Extinguished
181.	IN PROG State (Problem)	Illuminated/Extinguished
182.	INHB RMV State	On, Illuminated/Off, Extinguished
183.	INIT COND State	On, Illuminated/Off, Extinguished
184.	INSR State	On, Illuminated/Off, Extinguished
185.	INSTR CALL State	On, Illuminated/Off, Extinguished
186.	MALF State	On, Illuminated/Off, Extinguished
187.	MIN SEL Value	1 .. 5
188.	MON STUD HDST State	On, Illuminated/Off, Extinguished
189.	PAUSE State	On, Illuminated/Off, Extinguished
190.	PLOT AREA RCL State	On, Illuminated/Waiting, Flashing/Off, Extinguished
191.	PROB FRZ State	On, Illuminated/Off, Extinguished
192.	PROB RESET State	On, Illuminated/Waiting, Flashing/Off, Extinguished
193.	PROB Value	0 .. 9
194.	RADIO NAV State	On, Illuminated/Off, Extinguished
195.	RESET State (Playback)	On, Illuminated/Off, Extinguished
196.	RESET State (Problem)	On, Illuminated/Waiting, Flashing/Off, Extinguished
197.	SEL Value	0 .. 9
198.	SEMI AUTO State	On, Illuminated//Waiting, Flashing/Off, Extinguished
199.	SLOW State	Illuminated/Extinguished
200.	SLOW TIME State	On, Illuminated/Off, Extinguished
201.	STORD PLOTS State	On, Illuminated/Off, Extinguished
202.	UHF State	On, Illuminated/Off, Extinguished
203.	VHF NAV State	On, Illuminated/Off, Extinguished
204.	VHF State	On, Illuminated/Off, Extinguished